Materials & Methods

THE MAGAZINE OF MATERIALS ENGINEERING

1948 Metal Show Salutes Progress of Alloy Steels

Steel and Aluminum for Automotive Products Compared

Control of Surface Finish Improves Quality, Cuts Costs

Precision Investment Castings Reduce Assembly Operations

Plastisols of Vinyl Latices Are Versatile Coatings

Electrical Use of Aluminum Expands, Use of This Material

Zinc-Base Die-Casting Alloy Wet Die Processes

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Alloys for Steam

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October 1948

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NEXT MONTH: The Noble Metals in Industry . . . New Plastics Offer Wide Range of Properties and Fabricating Characteristics . . . Casting High-Conductivity Copper Alloys . . . Providing a Mirror Finish on the Inside of Stainless Steel Pails . . . Metal Powder Parts Replace Those Produced by Other Methods . . . A New Aluminum Extruding Alloy . . . Synthetic Sapphires Provide High Finish for Machine Parts . . . METAL CLEANING (Materials & Methods Manual No. 43)

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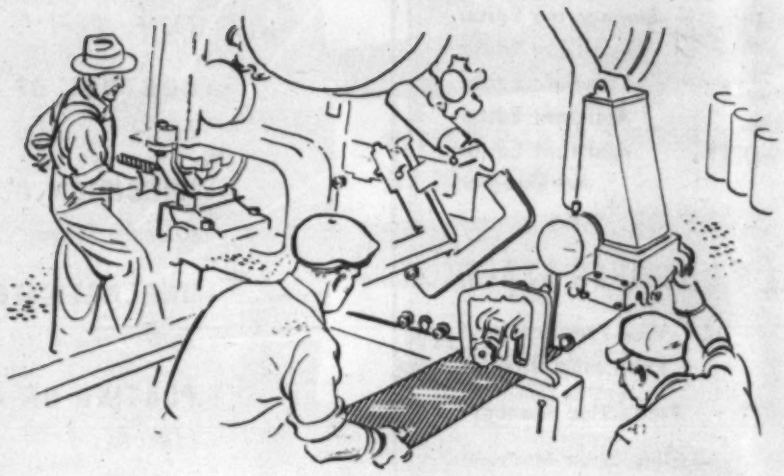

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The MATERIALS OUTLOOK...

Metal prices shouldn't go much higher. . . . U. S. Dept. of Commerce sees slowdown in postwar production climb. . . . Pace during past summer moderately lower than earlier in year. . . . Purchasing agents now buy hand-to-mouth, don't build up inventories. . . . U. S. stockpiling and ERP may cause spotty stiffening in metal markets. . . . But general softening expected by year's end.

Domestic pig iron's still scarce. . . . Sudden breakdown of Mystic Iron Work's blast furnace, near Boston, puts squeeze on N. E. foundries. . . . Some may shut down. Recent $6 per ton reduction in Austrian pig (now $77 per ton F.O.B. Trieste) puts it in competition with the gray market here. . . . N. E. foundrymen claim they will use all they can get. . . .

And speaking of scarcities, Chas. Sawyer, Secretary of Commerce, predicts that '49 will see a lead shortage of 124,165 tons, zinc, 47,700 tons, and copper, 100,000 tons. . . . Stockpiling may increase these figures.

Jamaican bauxite is slated for development. . . . Now that arguments and political contortions are over. . . . But power problem's still to be solved. . . . U. S. present Guiannan supply inadequate for future aluminum needs.

Embossed aluminum sheet is currently getting the nod for decorative and industrial applications. . . . A good slice of Reynolds Metals production is going to meet this trend. . . . Particularly 2S, 3S, and 52S. . . . Embossing isn't as deep or complex as in so-called "rigidized" metals. . . . Hence, lower price. . . . You can use it for anything from ironing boards to license plates. . . .

Incidentally, aluminum's relatively cheap. . . . Still priced 20% below prewar.

Increased use of zinc-base die castings indicates annual consumption of 250,000 tons by '49. . . . Projection of curve from '39 to '47 shows this. . . . But don't bet on it happening. . . . Crowded postwar manufacturing schedules pushed these castings into limelight. . . . They were easier to get than other materials. . . . But recent complaints of breakage under severe impact tend to dampen this boom. . . . And substitutes are now in order. . . . So the curve may ease off, not soar.

If you have any gallium, don't throw it away. . . . Uncle Sam wants it for a hush-hush reason. . . . It's the only metal other than mercury that is liquid at low temperature. . . . But has a high boiling point (highest liquid range of any known element). . . . New sources of low-grade gallium found recently. . . . Eagle-Picher has some. . . . Gallium presently produced only non-commercially. . . . It costs more than platinum. . . .

Thallium's another rare "ium" metal with a military use. . . . Formerly used only for rodent poisoning. . . . Now used in lenses and prisms of infra-red equipment. . . . Large quantities available in Salt Lake Valley, Utah.

First results of government cessation of war bonus to high-cost metal producers now apparent. . . . Nevada's zinc production dropped 25% in '47. . . . But lead production for U. S. has jumped. . . . Lead

(Continued on page 4)

The Materials Outlook *(Continued)*

miners are quitting marginal outfits to enter more profitable diggings.

You can expect to see a much greater use of clad metals from here on out. . . . Reason? Stockpiling program. . . . Plus need to hoard such strategic metals as chromium, tungsten, manganese, cadmium, et al.

Molded alumina is advocated for high temperature use . . . replacing steatite or other conventional ceramics. . . . Can be molded without appreciable shrinkage or deformation. . . . Can withstand continuous temperature above 3000 F. . . . Resists gas and slag corrosion. . . . Resists spalling. . . . And retains dimensional stability.

All-aluminum automobiles that get 35 to 40 mpg. are just over the next hill, according to C. B. Bohn of Bohn Aluminum & Brass. . . . Retooling expense is all that prevents immediate adoption of these lightweights, he says. . . . Motordom has yet to be heard from re this. . . . But at least such buggies would have the official blessing of resource-conscious conservationists in Washington. . . .

And speaking of automobiles, Powel Crosley, Jr. has junked the conventional method of rivetting linings to brake shoes. . . . Uses "Permafuse" plastic cement instead. . . . Claims it doubles brake life and gives greater driving safety.

New hardenable copper alloy recently developed in Britain. . . . Typical composition: 10 nickel, 10 manganese, 1% iron, balance copper. . . . Hardened by heating to 750 C and quenching. . . . Has exceptional resistance to sea water. . . .

English foundries booked tight on manganese bronze castings. . . . Why not more U. S. use of hard, strong bronzes instead of old tin bronzes???? Especially aluminum bronze, notably improved. . . . They're tougher, harder, more corrosion-resistant, more heat-resistant.

Price of standard ferromanganese. . . . F.O.B. producing or stock point. . . . Raised to $15 per gross ton, according to Electro Metallurgical Sales Corp. . . . Former cash discounts eliminated. . . . Low-carbon ferromanganese raised $0.0225 per lb. of contained manganese. . . . Medium-carbon grades up $0.0165. . . . Low-iron ferromanganese up $0.0135. . . . Manganese metal up 3¢ per lb. of metal. . . . Silico-manganese up 0.8¢ per lb. of alloy.

Silicones proving versatile. . . . Bearing out original predictions. . . . Motorcycle maker coats cylinders, exhaust pipes with silicone resins. . . . Claims they maintain film continuity for 24 hr. after heating to 1000 F. . . . And water quenching to 70 F. . . . Results: no softening, no blistering, no rusting, and no discoloration. . . .

Another interesting silicone application: Small drop of silicone fluid on automotive instrument bearings. . . . Prevents fluttering of needle. . . . Fluid holds same viscosity under temperature extremes.

Basic ferrous metallics in U. S. now inventory only 40% of our '41 total, according to R. W. Wolcott, American Iron & Steel Institute's scrap committee chairman. . . . Right now, 10 million tons of ferrous scrap lie in Germany. . . . 2 or 3 million exported to U. S. wouldn't hurt German economy, he says. . . . It certainly wouldn't hurt the scrap shortage here, either.

Low temperature (1300 F) porcelain enamels currently widening field of "glass coating". . . . Mature under lower critical of steel. . . . Do not replace standard porcelain finishes. . . . Discussed at Porcelain Enamel Institute's 10th Annual Forum, Oct. 13-15, University of Illinois, Urbana.

AN EDITORIAL

Are There Too Many Alloy Steels?

One of the features of the 1948 National Metal Congress (to be held in Philadelphia, October 25-29; see page 63, this issue) is "A Salute to Alloy Steel." Papers and exhibits prepared specially for this theme, plus the conferring of several Distinguished Service Awards on persons that have made outstanding contributions to alloy steel development, will give due and proper recognition to the basic role of modern alloy steels in our increasingly technological society. We join wholeheartedly in the salute, and commend the A.S.M. for honoring real achievement in this way.

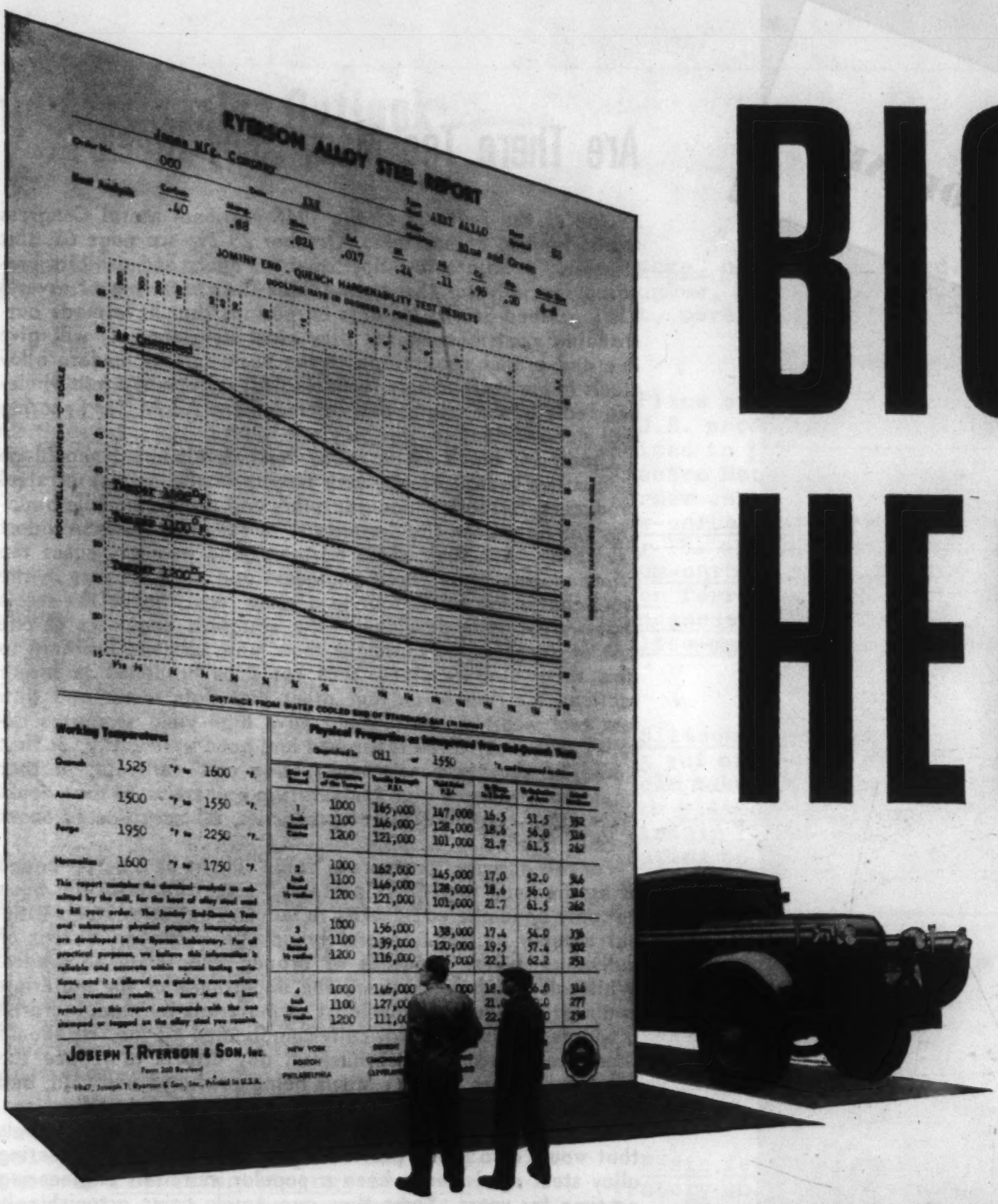
Credit for much of our alloy steel development should go to creative metallurgists, very largely in the employ of steel producers, ferroalloy manufacturers and the automobile builders, who have been the "inventors" of the alloy steels in widest use today. But their close partners, and in many cases the prime movers, were those engineers and metallurgists in the steel-consuming fields that in a sense *requisitioned* the steels that were finally developed—the materials engineers of one sort or another who besought their more creative brethren to give them durable steels that could be hardened in larger sections; or that would cut other materials faster and with less tool wear; or that would have high yield strengths as-rolled, extra corrosion resistance and good weldability; or that would be simultaneously non-rusting and workable; or that would have superior high temperature properties; or that would offer other combinations of properties, all specified in exact detail.

For this activity "partners in crime" might be a better badge of brotherhood than just "partners," since the result has been not only unnumbered benefits to industry but *alloy steels* without number as well—several broad classifications, dozens of individual types, hundreds of brands, thousands of grades. While all this has increased the importance of the materials engineer as industry's specialist on materials for manufactured products, it has also terrifically complicated his job. He should therefore regard with enthusiasm any efforts to reduce the number of types of alloy steels being produced and sold, and to standardize on grades within the various type classifications.

Attempts to fasten on two or three grades of alloy steels that would as a group provide for all the common engineering alloy steel needs, have been a popular materials engineering pastime for years. Some time ago Amola came astonishingly close to doing it with that one steel alone. Today at least one alloy steel producer is vigorously promoting an alloy-steel-application program based on just two grades, and other producers are leaning strongly toward reduction in the number of grades.

Materials engineers can aid this highly desirable trend by rigidly standardizing their own requirements, both individually and collectively, on the smallest possible number of types and grades of alloy steel. Two or three steels may not be quite enough for some, but two or three dozen are surely too many. Too many steels means too many headaches, for the steel user, the producer and both of their cost accountants. And, as these last would say, why add to our burden?

FRED P. PETERS



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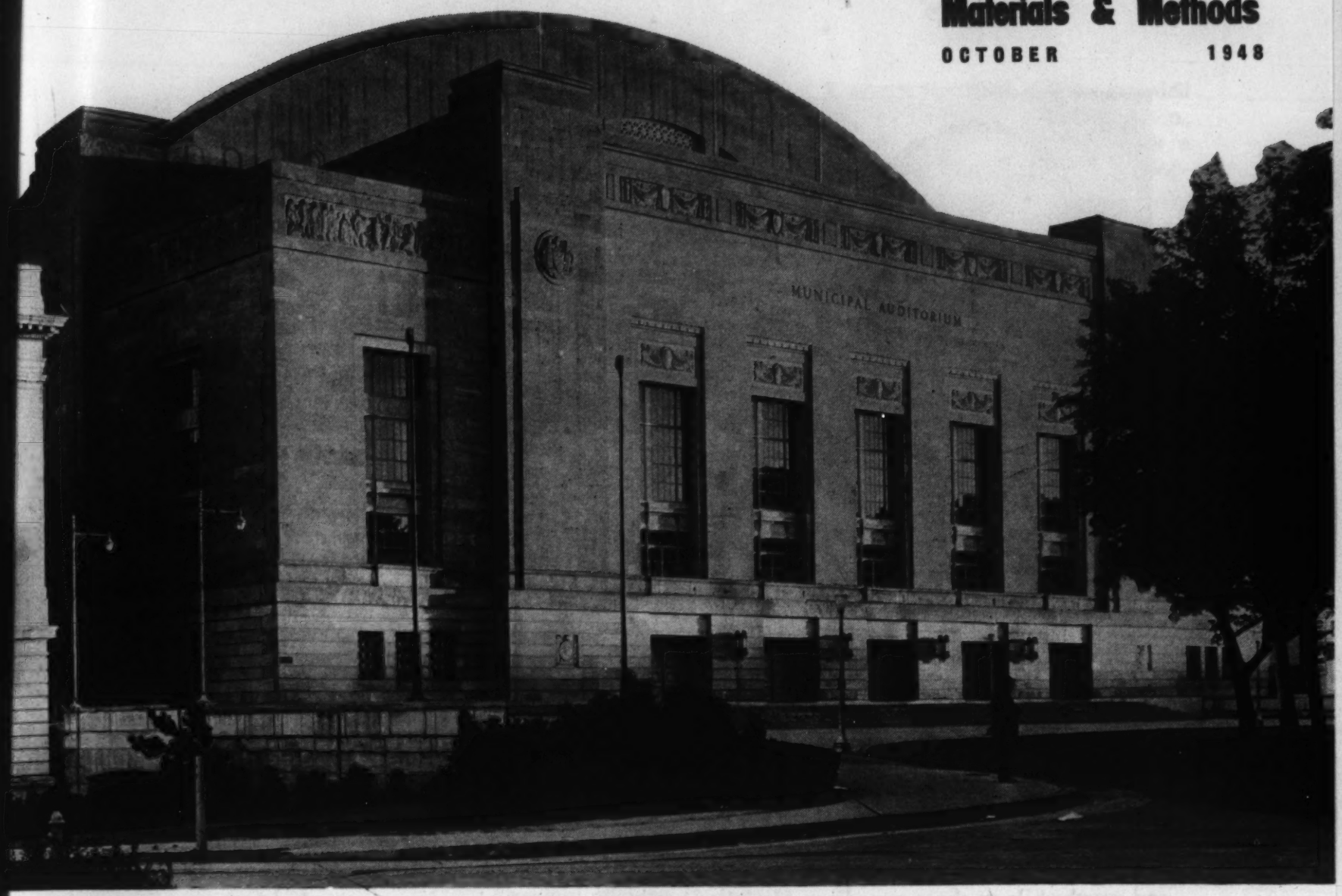

1948 Metal Show

Salutes Progress of Alloy Steels

IN 1873 AND 74 WHEN the famous Eads Bridge was planned and erected across the Mississippi at St. Louis, an important milestone in metallurgical history was also being made. For in the main arches of this bridge a chromium-carbon steel served as some of the compression members and thereby became the first alloy steel to be used in a major engineering structure.

Alloy steels have come a long way since that initial application, and to celebrate the 75 years of progress made by this important group of engineering materials, the central theme of the 30th National Metal Congress and Exposition, to be held in Philadelphia the week of October 25, will be "A Salute to Alloy Steel." Principal features of this diamond jubilee for alloy steel will be: First, a program of technical and historical papers about alloy steel. Second, a presentation of Distinguished Service Awards to individuals who have made outstanding contributions to the progress and development of alloy steels. An awards committee has been formed to consider submitted nominations and to select outstanding men, now living, in various branches of the alloy steel field. Third, there will be a display of the part played by alloy steels in the history of the United States. This feature will include graphic exhibits on the main stage of the

Harold K. Work (left), Jones & Laughlin Steel Corp., is the President-Elect of the American Society for Metals. Francis B. Foley (right), Midvale Corp., is the retiring President.

Exposition Hall illustrating the progress through the years of alloy steels and a display of alloy steel products.

These special events, in addition to the regular list of activities always associated with the Metal Show, should make this 1948 edition particularly interesting and worthwhile to those attending. High on the list of regular activities, of course, is the Exposition. It promises to have all the ingredients that have previously attracted thousands of members of the metals industries. It is expected that there will be between 300 and 400 exhibits covering many of the latest developments in materials and methods and equipment for the metal working industries. The exposition will open at 12 noon daily and close at 10:30 P.M., except Thursday and Friday, Oct. 28 and 29, when the exhibit will open at 10:00 A.M. and close at 6:00 P.M.

As in previous years, the American Society for Metals is sponsoring the event and three other technical societies are participating with technical meetings during the week. They are the American Welding Society, the Institute of Metals Division of the American Institute of Mining & Metallurgical Engineers, and the Society for Non-Destructive Testing.

American Society for Metals

In addition to the features of the diamond jubilee for alloy steels, already described, the American Society for Metals will have their regular program of interesting and timely activities. There will be a program of technical papers running Monday through Friday. In keeping with the central theme, 19 of the papers will report on developments in the science and technology of alloy steels. Other topics on which papers will be presented include heat treating, nonferrous alloys, physics of metals, and testing. Of particular interest to materials engineers should be the two sessions on mechanical and engineering properties which will cover the service characteristics and performance of a number of ferrous metals (see Consolidated Program for time and place). Besides the regular technical sessions, there will be a special report on the history of alloy steel in the United States, and a symposium on the cold working of steel.

The very popular Educational Lectures will be continued this year, with three courses scheduled during the first three days of the week. The subjects are: Properties of Metals for Design, Metallurgy and Magnetism, and Recrystallization and Grain Growth in Metals.

One of the highlights of the ASM conclave always has been the Edward de Mille Campbell Memorial Lecture, traditionally presented at the annual meeting. This year, on Wednesday morning, the lecture will be delivered by the well-known Morris Cohen, professor of physical metallurgy at the Massachusetts Institute of Technology. At the same session the new officers of the Society will be officially announced. They are: H. K. Work, President; A. E. Focke, Vice-President; H. P. Croft and F. J. Robbins, Trustees.

Finally, climaxing the week's activities will be the annual banquet on Thursday evening at the Hotel Benjamin Franklin. Features of the dinner will be the presentation of annual awards bestowed by the society for outstanding achievements in the field of

metals. The Gold Medal for outstanding metallurgical knowledge and versatility in the application of science to the metal industries will be presented to Francis Cowles Frary, Director of Research, Aluminum Company of America. The Society's Medal for Advancement of Research for 1948 will be awarded to Willard H. Dow, President, Dow Chemical Co., for his consistent support and sponsorship over a period of years of metallurgical research and development.

Institute of Metals Division, AIME

During the past year the ferrous and nonferrous metal groups of the American Institute of Mining & Metallurgical Engineers have been combined, so their fall meeting this year will be under one division, the Institute of Metals Division. As in former years, the program will extend over the first three days of the week.

One of the main features will be a symposium on rod and wire. This is the third in a series of symposia being conducted by the society. This one is designed to be of particularly practical value to producers and fabricators of these important metal forms. Of particular value from the standpoint of materials engineering will be the introductory paper, which will give a comprehensive appraisal of wire products in industry. The other papers of the symposium will deal with a number of technical and production aspects in the manufacture of rod and wire products. Also of practical interest are two groups of papers covering the engineering properties of a variety of metals and alloys including the light metals, and alloys of tin, of copper, and of zinc. For those interested in the physics of metals and other fairly technical aspects of metals, there will be sessions on plastic deformation, constitution and precipitation, microscopy and grain growth, and diffusion and surface phenomena.

The annual fall dinner of the Metals Division will be held on Tuesday evening at Hotel Adelphia. The main speaker will be Dr. Waldo E. Fisher of the University of Pennsylvania, who will speak on a timely topic, "The Taft-Hartley Act; An Appraisal."

American Welding Society

The American Welding Society can always be counted on to have the largest number of technical papers at the Metal Show, and this year is no exception. Their technical program consists of about 60 papers which cover practically every phase of the welding field. From this wide selection, the engineer can usually find at least a few papers which touch his specific field of interest. There will be sessions on various types of welding and cutting; also on brazing and metallizing. Problems involved in welding specific materials will be discussed in a number of papers, and one session will be devoted exclusively to the welding of high alloys. In addition, there will be two sessions devoted to the recent work done on welded ship structures.

A new feature of the A.W.S. Annual Meeting, starting this year, is an Educational Lecture Series. The series, sponsored by the Educational Committee of the Society, will cover the metallurgy of arc welds in steel, and will be open to all members and guests. In addition, there will be the regular welding and cutting demonstrations at the Convention Hall during the entire week.

Other highlights include the President's Reception on Sunday evening, October 24. The awards of prizes and medals will be made on Monday evening, at which time the Adams Lecture will be delivered by G. E. Claussen of the Reid-Avery Co. His subject will be "The Metallurgy of Covered Electrode Weld Metal." Finally, the annual dinner will be held on Thursday evening at the Bellevue-Stratford Hotel

Society for Non-Destructive Testing

Bringing with them a new name, the Society for Non-Destructive Testing (formerly the American Industrial Radium & X-Ray Society) will meet for their annual meeting Wednesday and Thursday of the Metal Show week. The technical program reflects the change of name by including several papers on testing methods other than radiography, including one on radio-isotopes, another on magnetic particle inspection, and another on X-ray diffraction. The 1948 Mehl Lecture will be delivered by Dr. Floyd A. Firestone, whose subject will be "The Supersonic Reflectoscope, an Instrument for Non-Destructive Testing and Measuring by Means of Sound Waves." The papers on radiography will cover many of the latest developments in this field, such as applications of multi-million volt X-rays, spotweld radiography, and high-speed cine radiography.

Given here is a consolidated program listing the activities of the four participating societies. The events are integrated chronologically, so that the reader can see at a glance what sessions are occurring at any specific time.

Monday, October 25

A.M.		
9:00	**AIME**	Properties of Metals and Alloys. Jefferson Room, Adelphia.
	AIME	Microscopy and Grain Growth. Crystal Room, Adelphia.
9:30	**ASM**	Heat Treatment Session. Ball Room, Benjamin Franklin.
	AWS	Ship Design. South Garden, Bellevue-Stratford.
	AWS	Railroad Welding. North Garden, Bellevue-Stratford.
	AWS	Storage Tanks, Pressure Vessels & Piping. Rose Garden, Bellevue-Stratford.
P.M.		
2:00	**ASM**	Heat Treatment Session. Ballroom, Convention Hall.
	AIME	Properties of Metals and Alloys. Jefferson Room, Adelphia.
	AIME	Constitution and Precipitation. Crystal Room, Adelphia.
4:15	**ASM**	Educational Lecture: Properties of Metal for Design. Room 300, Convention Hall.
4:30	**AWS**	Educational Lecture: Metallurgy of Arc Welds in Steel. Convention Hall.
5:15	**ASM**	Educational Lecture: Metallurgy and Magnetism. Ballroom, Convention Hall.
8:00	**AWS**	Adams Lecture and Awards Presentation. Rose Garden, Bellevue-Stratford.
	ASM	Educational Lecture: Properties of Metal for Design. Room 300, Convention Hall.

EDUCATIONAL LECTURE COURSES

Properties of Metals and Design (ASM)

Four Lectures: Monday at 4:15 and 8.00 P.M., and Tuesday at 4:15 and 8:30 P.M.

Recrystallization and Grain Growth in Metals (ASM)

Four Lectures: Tuesday at 8:30 P.M., Wednesday at 4:15 P.M. and 8:00 P.M., and Thursday at 4:15 P.M.

Metallurgy and Magnetism (ASM)

Four Lectures: Monday, Tuesday and Wednesday at 5:15 P.M.

The Metallurgy of Arc Welds in Steel (AWS)

Three Lectures: Monday, Tuesday and Wednesday at 4:30 P.M.

All lectures will be given at Convention Hall.

Tuesday, October 26

A.M.		
9:00	**AIME**	Plastic Deformation. Jefferson Room, Adelphia.
	AIME	Rod and Wire Production Symposium, Crystal Room, Adelphia.
9:30	**ASM**	Steel Ingots Session. Ballroom, Benjamin Franklin.
	ASM	Nonferrous Alloys Session. Betsy Ross Room, Benjamin Franklin.
	AWS	Symposium on Ship Structure Research. South Garden, Bellevue-Stratford.
	AWS	Railroad Welding. North Garden, Bellevue-Stratford.
	AWS	High Alloys. Rose Garden, Bellevue-Stratford.
P.M.		
2:00	**ASM**	Mechanical Properties Session. Ballroom, Convention Hall.
	AIME	Plastic Deformation. Jefferson Room, Adelphia.
	AIME	Rod and Wire Production Symposium. Crystal Room, Adelphia.
	AWS	Symposium on Ship Structure Research. South Garden, Bellevue-Stratford.
	AWS	Brazing and Metallizing. North Garden, Bellevue-Stratford.
	AWS	Cutting. Rose Garden, Bellevue-Stratford.
4:15	**ASM**	Educational Lecture: Properties of Metals for Design. Room 300, Convention Hall.
4:30	**AWS**	Educational Lecture: Metallurgy of Arc Welds in Steel. Convention Hall.
5:15	**ASM**	Educational Lecture: Metallurgy and Magnetism. Ballroom, Convention Hall.
7:00	**AIME**	Annual Dinner. Crystal Room, Adelphia.
7:30	**ASM**	Educational Lecture: Properties of Metal for Design. Room 300, Convention Hall.
8:30	**ASM**	Educational Lecture: Recrystallization and Grain Growth in Metals. Ballroom, Convention Hall.

Wednesday, October 27

A.M.		
9:30	**AWS**	Weldability. Rose Garden, Bellevue-Stratford.
	AWS	Cutting. North Garden, Bellevue-Stratford.
	AWS	Resistance Welding. South Garden, Bellevue-Stratford.
	SNT	Industrial Application of Soft Radiation; Installation and Adjustments of Mobile Betatron; Field Processing of Radiographic Films. Benjamin Franklin.
10:00	**ASM**	Annual Meeting and Edward de Mille Campbell Memorial Lecture. Ballroom, Benjamin Franklin.
P.M.		
2:00	**ASM**	Engineering Properties Session. Ballroom, Convention Hall.
	AIME	Diffusion and Surface Phenomena. Jefferson Room, Adelphia.

	AIME	Transformation. Crystal Room, Adelphia.
	AWS	Arcs and Electrodes. Rose Garden, Bellevue-Stratford.
	AWS	Inert-Gas-Shielded Arc Welding. North Garden, Bellevue-Stratford.
	AWS	Resistance Welding. South Garden, Bellevue-Stratford.
	SNT	High Speed Cine Radiography; Gamma Radiography of Bronze Castings; Radiography of Abrasive Wheels; Spotweld Radiography. Benjamin Franklin.
4:15	**ASM**	Educational Lecture: Recrystallization and Grain Growth in Metals. Room 300, Convention Hall.
4:30	**AWS**	Educational Lecture: Metallurgy of Arc Welds in Steel. Convention Hall.
5:15	**ASM**	Educational Lecture: Metallurgy and Magnetism. Ballroom, Convention Hall.
8:00	**ASM**	Educational Lecture: Recrystallization and Grain Growth in Metals. Room 300, Convention Hall.
	AWS	University Conference. Bellevue-Stratford.

Thursday, October 28

A.M.		
9:30	**ASM**	Stainless Steels Session. Ballroom, Convention Hall.
	ASM	Nonferrous Alloys Session. Room 300, Convention Hall.
	AWS	Structural Welding. Rose Garden, Bellevue-Stratford.
	AWS	Inert-Gas-Shielded Arc Welding. North Garden, Bellevue-Stratford.
	AWS	Maintenance Welding. South Garden, Bellevue-Stratford.
	SNT	X-Ray Diffraction of Magnetic Materials; Testing Methods for Ceramic Products; Exposure Calculator for Radium Radiography. Benjamin Franklin.
P.M.		
2:00	**ASM**	High Temperature Alloys Session. Ballroom, Convention Hall.
	SNT	Annual Meeting and Mehl Lecture. Benjamin Franklin.
4:15	**ASM**	Educational Lecture: Recrystallization and Grain Growth in Metals. Room 300, Convention Hall.
Evening	**ASM**	Annual Banquet. Benjamin Franklin.
	AWS	Annual Dinner. Rose Garden, Bellevue-Stratford.

Friday, October 29

A.M.		
9:30	**ASM**	Physics of Metals Session. Ballroom, Convention Hall.
	AWS	Automatic Welding. South Garden, Bellevue-Stratford.
	AWS	Miscellaneous Papers. Rose Garden, Bellevue-Stratford.
	AWS	Hard Facing and Flame Hardening. North Garden, Bellevue-Stratford.
P.M.		
2:00	**ASM**	Testing Session. Ballroom, Convention Hall.
	AWS	Business Session. South Garden, Bellevue-Stratford.

EXHIBITORS AND THEIR BOOTH NUMBERS NATIONAL METAL EXPOSITION, PHILADELPHIA, OCT. 25-29, 1948

EXHIBITORS	BOOTH NUMBER
Acetogen Gas Co.	A-1549
Acme Mfg. Co.	618
Acme Steel Co.	737
Acme Tool Co.	1909
Air Reduction Sales Co.	1845
Ajax Electric Co.	645
Ajax Electrothermic Corp.	645
Ajax Engineering Corp.	645
Alan Wood Steel Co.	1809
Aldan Welding Supplies, Inc.	A-1567
Allison Co.	705
Alloy Rods Co.	345
Alvey-Ferguson Co.	1819
American Brake Shoe Co.	126
American Brass Co.	337
American Chain & Cable Co., Inc.	116
American Chemical Paint Co.	1654
American Cladmetals Co.	124
American Emblem Co.	1729
American Gas Assn.	1301
American Gas Furnace Co.	1509
Amer. Inst. of Bolt, Nut & Rivet Mfg. Assn.	1564
American Manganese Steel Co.	126
American Metal Market Co.	1918
American Non-Gran Bronze Corp.	1767
American Smelting & Refining Co.	231
Anderson Oil Co., F. E.	1629
Arcos Corp.	144
Army Industrial & Recruiting Display	1357
Aronson Machine Co.	1963
Arwood Precision Casting Corp.	1427
ASM—Philadelphia Chapter	A-1554
Atkins & Co., E. C.	831
Audubon Wire Cloth Corp.	1545
Austenal Laboratories, Inc.	1428
Auto Arc-Weld Mfg. Co.	1765
Automatic Temperature Control Co., Inc.	104
Automotive Industries	1959
Baker & Co., Inc.	1853
Baldwin Locomotive Works	1620
Bastian-Blessing Co.	1816
Bath & Co., Cyril	1520
Battelle Memorial Institute	1754
Bausch & Lomb Optical Co.	310
Bellis Heat Treating Co.	1356
Bendix-Westinghouse Air Brake Co.	817
Black Drill Co.	656
Blakeslee & Co., G. S.	1762
Brown Instrument Co.	203
Brush Beryllium Co.	906
Bryant Heater Co.	1315
Buehler, Limited	441
Butler Cylinder Gas Co.	A-1567
By-Products Steel Co.	320
Cambridge Wire Cloth Co.	1424
Campbell Machine Div., Am. Chain & Cable Co.	116
Carbomatic Corp.	1302
Carlin Co., Inc., J. A.	1657 & 1658
Cherry Rivet Co.	742
Chilton Co.	1959
Cincinnati Milling & Grinding Machine Co.	1510
Cities Service Oil Co.	402
Cleveland Punch Shear Co.	1733
Clinton Machine Co.	1836
Colonial Alloys Co.	1662
Commander Mfg. Co.	941
Commerce Pattern Foundry Machine Co.	1525
Continental Industrial Engineers, Inc.	145
Crane Packing Co.	1530
Crystal Lake Grinders	1562
Delaware Tool Steel Corp.	121
Delta File Works	1332
deSanno & Son, A. P.	1362
Despatch Oven Co.	1415
Detroit Mold Engineering Co.	A-1562
Detroit Testing Machine Co.	1830
Dietert Co.	208
Distillation Products, Inc.	1909
Diversey Corp.	1815
Donovan Co.	844
Dow Chemical Co.	416
Dreis & Krump Mfg. Co.	718
Drever Co.	1653
Drexell Institute of Technology	A-1558
Driver Co., Wilbur B.	1810
du Pont de Nemours & Co., E. I.	1665
East Shore Machine Products Co.	756
Ecco High Frequency Corp.	1467
Eclipse Fuel Engineering Co.	1410-(With AGA)

EXHIBITORS AND THEIR BOOTH NUMBERS NATIONAL METAL EXPOSITION, PHILADELPHIA, OCT. 25-29, 1948

EXHIBITORS	BOOTH NUMBER
Edgecomb Steel Co.	109
Electric Furnace Co.	221
Electric Hotpack Co., Inc.	1763
Electro Alloys Div.	126
Elge Associates	1454
Engelhard, Inc., Charles	A-1561
Eutectic Welding Alloys Corp.	1633
Fansteel Metallurgical Corp.	101
Federated Metals Div.	231
Ferner Co., R. Y.	1927
Finishing Publications, Inc.	603
Foote Mineral Co.	1554
Fostoria Pressed Steel Corp.	1558
Frankford Arsenal	1357
Frontier Bronze Corp.	316
Gamma Scientific Co.	A-1563
Gardner Publications	1345
Gas Appliance Service	1310
Gehnrich & Gehnrich, Inc.	1307
General Alloys Co.	204
General Controls Co.	1346
General Electric X-Ray Corp.	246
Goodrich Co., B. F.	638
Griffith-Raguse & Co., Inc.	1657
Gulf Oil Corp.	1616
H. & H. Research Co.	1909
Hamilton Manufacturing Co.	1576
Handy & Harman	132
Hanson-Van Winkle-Munning Co.	607
Harnischfeger Corp.	1728
Harper Electric Furnace Corp.	605
Harvey Machine Co., Inc.	1449
Hauck Manufacturing Co.	1326
Hayes, Inc., C. I.	1557
Haynes Stellite Co.	1602
Heli-Coil Corp.	1330
Hobart Brothers Co.	944
Hones, Inc., Charles A.	1304
Houghton & Co., E. F.	832
Hunter Spring Co.	1666
Illinois Testing Laboratories, Inc.	1431
Industrial Heating	1533
Industrial Press	1860
Industrial Publishing Co.	440
Industry & Welding	440
International Nickel Co.	226
International Tin Research Inst.	1325
Invincible Vacuum Cleaner Mfg. Co.	1566
Iron Age	410
Jackson Buff Corp.	1710
Jackson Products	1933
Janney Cylinder Co.	1450
Jarrell Ash Co.	1761
Jelliff Mfg. Corp., C. O.	1850
Joseph, E. R.	A-1567
K-E Industries	1929
Kalamazoo Tank & Silo Co.	1462
Kanthal Co., A. B.	1850
Keen Compressed Gas	A-1567
Kemp Mfg. Co., C. M.	1318
Kent Co., Inc.	1957
King, Andrew	411
Kropp Forge Co.	848
Krouse Testing Machine Co.	133
Kux Machine Co.	908
Leeds & Northrup Co.	1910
Lepel High Frequency Laboratory	1749
Libert Machine Co.	718
Lincoln Electric Co.	1645
Lindberg Engineering Co.	344
Linde Air Products Co.	1602
Lipe Rollway Corp.	A-1546
Liquid Carbonic	1931
Lithium Co.	1409
Lobdell Co.	1856
Los Angeles Chamber of Commerce	1344
Los Angeles (Dept. of Water & Power)	1344
Lukens Steel Co.	320
Lukenweld Div.	320
Lynch Machinery Co., Edw. A.	718
Machinery	1860
Machinery & Welder Corp.	1553
Magnaflux Corp.	723
Magnetic Analysis Corp.	1826
Mallory & Co., Inc., P. R.	637
Manganese Steel Forge Co.	1545
Manhattan Rubber Div.	1550
Materials & Methods	107
McCracken & Sons, Inc., R. S.	A-1567
McGraw-Hill Publishing Co., Inc.	1844
McKay Co.	1833
Meehanite Metal Corp.	1610
Merrill Brothers, Inc.	A-1553
Metal & Thermit Corp.	426
Metal Finishing Service	1924
Metallizing Co. of America	741
Metal Progress	241
Metals Disintegrating Co., Inc.	937
Metals Review	241
Metlab Co.	113
Michiana Products Corp.	1650
Michigan Steel Casting Co.	914
Micro Metallic Corp.	1664
Midvale Co.	238
Milne & Co., A.	1366
Milton Equipment Co.	1715
Minneapolis-Honeywell Regulator Co.	203
Morton Gregory Corp.	856
Motch & Merryweather Machinery Co.	642
National Bronze & Aluminum Foundry	902
National Carbon Co., Inc.	1602
National Diamond Hone & Wheel Co.	1848
National Industrial Publishing Co.	1533
National Lead Co.	1915
National Radiator Co.	606
National Research Corp.	601
Naval Gun Factory	1752
Navy Dept.	1752
New Jersey Zinc Co.	326
Niagara Blower Co.	A-1544
North American Philips Co.	147
Northwestern Tool & Engineering Co.	1360
Ohio Crankshaft Co.	304
Ohio Seamless Tube Co.	623
Olsen Testing Machine Co.	1529
Optimus Equipment Co.	612
Osborn Mfg. Co.	631
Packer Machine Co.	1710
Pangborn Corp.	841
Park Chemical Co.	340
Parker-Kalon Corp.	1949
Partlow Corp.	1936
Penton Publishing Co.	1744
Pereny Equipment Co.	1752
Philadelphia Electric Co.	1857
Phillips Manufacturing Co.	711
Physicists Research Co.	125
Plastic Metals Div.	606
Poole, C. A.	1755
Porter-McLeod Machine Co.	1921
Precision Shapes, Inc.	A-1557
Precision Welder & Machine Co.	624
Production Machine Co.	1327
Pyrometer Instrument Co., Inc.	727
Quigley Co., Inc.	738
Radio Corp. of America	110
Ransburg Electro-Coating Corp.	1544
Ransome Machine Co.	1628
Raybestos-Manhattan, Inc.	1550
Reed Engineering Co.	1858-718
Reeves Pulley Co.	1435
Reinhold Publishing Corp.	107
Revere Copper & Brass, Inc.	702
Reynolds Metals Co.	1632
Richards Co., J. A.	628
Riverside Metal Co.	1758
Rolock, Inc.	1432
Safety Clothing & Equipment Co.	837
Salkover Metal Processing	A-1559
Sargeant & Wilbur, Inc.	1537
Scherr Co., Inc., George	417
Schrader's Son, A.	1835
Sciaky Bros., Inc.	1619
Scott & Son, Inc., C. U.	408
Scoville Manufacturing Co.	950
Selas Corp. of America	1401
Sentry Co., The	413
Shell Oil Co., Inc.	1823
Simonds Saw & Steel Co.	1822
Simonski, Gilbert S.	1351
Snap-On Tools Corp.	1955
Socony-Vacuum Oil Co., Inc.	1720
South Bend Lathe Works	1866
Southern California Edison	1344
Southern California Gas Co.	1344
Spencer Turbine Co.	217
Sperry Products, Inc.	139
Stearns-Roger Mfg. Co.	1321
Steel	1744
Stokes Machine Co., F. J.	1920
Stoody Co.	938
Stuart Oil Co., Ltd., D. A.	211
Sun Oil Co.	615
Superior Tube Co.	1829
Surface Combustion Corp.	1416
Tabor Manufacturing Co.	A-1565
Taco West Corp.	904
Tatnall-Young Testing Machine Corp.	104
Taylor-Winfield Corp.	1532
Technical Publishing Co.	440
Tempil Corp.	309
Temple University	A-1550
Tennant Co., G. H.	1336
Texas Co.	1563
Tide Water Associated Oil Co.	1436
Timken Roller Bearing Co.	446
Tinnerman Products	336
Torit Mfg. Co.	760
Torrington Mfg. Co.	632
Tri-Clover Machine Co.	1923
Udylite Corp.	214
Union Carbide & Carbon Co.	1602
U. S. Hoffman Machinery Corp.	838
U. S. Naval Eng. Experiment Station	1752
Upton Electric Furnace Div.	1525
Vacuum Equipment Div.	1909
Vanadium Corp. of America	117
Vapor Blast Mfg. Co.	1967
Vascoloy-Ramet Corp.	101
Wall Chemical Div.	1931
Webb Corp.	718
Welders Supply	A-1567
Welding Engineer	1844
Wells, Inc., Martin	1455
Wells Manufacturing Co.	1661
Westinghouse Electric Corp.	806
Whistler & Son, Inc., S. B.	1502
Whiting Corp.	718
Willys-Overland Motors, Inc.	1644
Wilson Mechanical Instrument Co., Inc.	116

Before a switch from steel to aluminum can be made in an automotive part, careful analysis must be made of cost and ease of processing. (Courtesy: Buick Motor Div., General Motors Corp.)

Steel and Aluminum for Automotive Products Compared

by **D. F. TOOT,** Project Engineer, Chrysler Corp.

THERE ARE TWO FACTORS that greatly influence the use of aluminum and its alloys in place of iron and steel in automobile manufacture; namely, cost and ease of manufacture. Parts must be built as easily and as cheaply as possible. However, if it is found that a part will function better if made of aluminum than of steel, then everything possible should be done to overcome objections based upon either cost or difficulty of production. It is this continual effort to use the best material for the job that has considerable effect on the development of new techniques which rapidly change the picture as far as these two factors are concerned. Keeping in mind cost and ease of processing, let us examine and compare some of the pertinent properties of aluminum, steel and cast iron and see how they can affect automobile design.

Widespread adoption of aluminum by the automotive industry awaits improvement of processing techniques.

Strength Properties

In designing a load-carrying part, it is first necessary to check a number of critical points to see what size the cross section would have to be in order that

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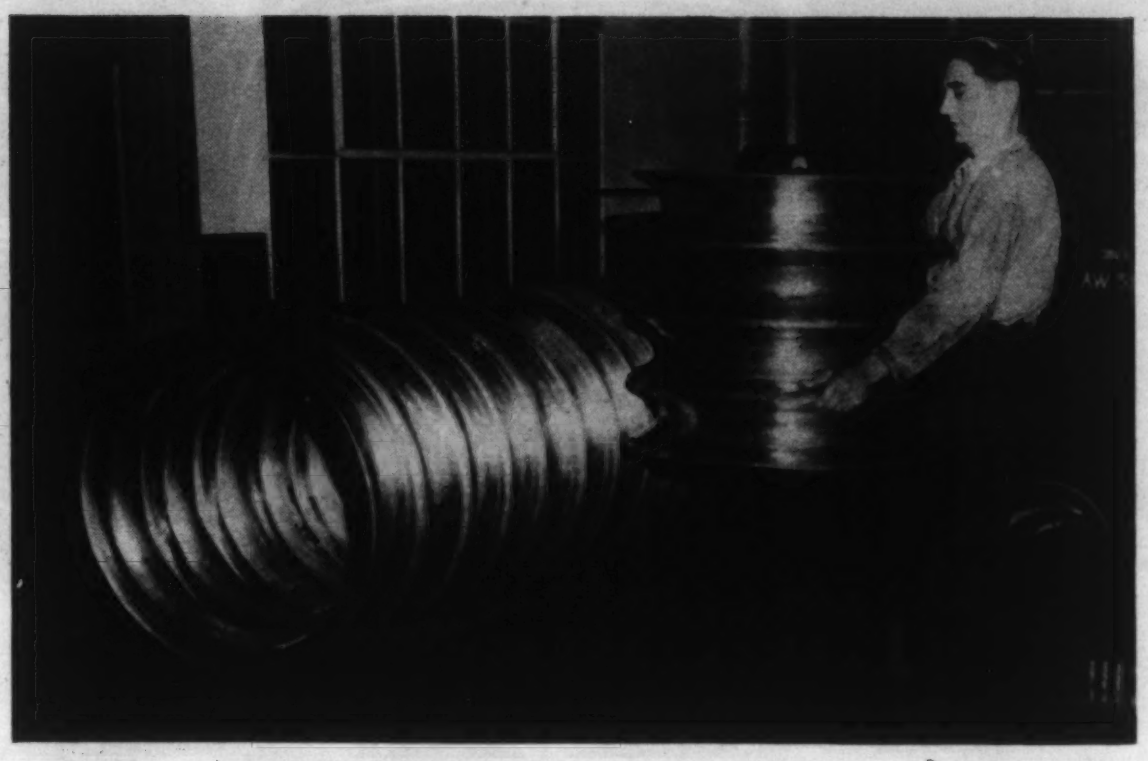


These truck tire flap curing rims of 2S aluminum result in a weight saving of 60%. The rims are rolled from flat aluminum strip and flash-butt resistance welded. (Courtesy: American Welding & Mfg. Co.)

the part would not fail under the maximum load it would be expected to carry. In most cases, this means that the yield strength of the material must be exceeded since a bent part usually has lost its ability to function properly.

In both mild steel and unheat-treated wrought aluminum, the yield strength varies considerably with the amount of cold-working before or during fabrication. For example, the yield strength of cold rolled steel is about 100% greater than that for fully annealed steel of the same analysis. A similar increase in yield strength is realized, although to a much lesser degree, by cold forming operations. This latter improvement is seldom utilized, however, since the amount of cold working varies considerably and it is only in the region of sharp bends that anywhere near 100% is obtained. A few parts which have a considerable amount of forming have been found satisfactory by experimental testing when made of a lighter gage than a theoretical stress analysis would indicate possible.

In unheat-treated wrought aluminum, the variation in yield strength due to cold working is considerably greater, the difference between dead soft and full hard material amounting to 350 to 400%. This difference is too great to be ignored as it so often is in steel stampings. In a great many parts, by paying special attention to the depth of draw and radius of bend, ¼ hard or ½ hard blanks can be used and the yield strength of the resulting material will be only slightly less than that of steel. An increase in gage of 10 to 15% in such an aluminum part over that of a corresponding steel part should make up this difference. However, in the design of parts where severe draws or sharp corners are unavoidable and dead soft sheet must be used, the yield strength will remain low in those portions where little cold working has occurred. In such a case, if the unworked portion is also a stressed portion, the aluminum may have to be twice as thick as steel in order to have a resulting part which is comparable in strength. An example of this was encountered in some experimental aluminum alloy fenders in which the material was about 40% thicker than that in corresponding steel fenders. Due to the fact that the material in a portion of the crown of the fender was only slightly cold worked, the yield strength at this section remained comparatively low. As a result, stones striking the underside of the fender quite seriously dented this portion. However, it is probable that with some changes in the forming operations and possibly some local annealing, it would be possible to start with a higher temper material and thus make a successful fender with the same thickness of aluminum as was tested.

Unheat-treated aluminum sand castings in general have a yield strength about 50% as high as the strength of ordinary gray iron castings, which run between 20,000 to 30,000 psi. This would normally mean that the stressed aluminum sections would have to be about 45% thicker than corresponding iron sections. However, it should be remembered that a great many iron castings are thicker than necessary in order to take care of core shifting, metal flow, etc.; and as far as static strength is concerned, it is probable that 80% of the cast iron sections would not have to be increased if the part were made of aluminum. Of course, there are cast irons whose strength is much more than 30,000 psi. To replace with aluminum parts made of such material, it is necessary to resort to either heat-treated permanent-mold castings or an increase in section proportionately larger than indicated in this paper.

The yield strength of aluminum alloy die castings is about 25% less than the strength of gray iron, but this difference could be corrected by an increase in section of about 15%. As a matter of fact, since die castings can be made with so much thinner sections

than is possible with gray iron, it could be expected that, from a purely static strength angle, many sections of the die castings could be made much thinner than the corresponding iron sections. The fact that many more ribs and more complicated rib patterns can be used in die casting even may make it possible to reduce some sections which in cast iron are rather highly stressed. There has been a feeling in the past that, due to extreme internal porosity, aluminum die castings could not safely be used for a part which had to carry an appreciable load. With present equipment and techniques, the porosity of this interior material can be controlled very closely, except in spots like heavy bosses.

In the case of aged but unheat-treated permanent-mold aluminum alloy castings, the yield strength is probably 10% higher than the strength of the previously mentioned 20,000 to 30,000 psi. gray iron. This would indicate a possible thinning of sections of the aluminum alloy casting, not only in those places where the gray iron section is determined by foundry practice, but also in those heavier sections which are designed to carry a certain load.

There are a few parts in the engine, fluid couplings and torque converters where temperatures are reached that appreciably reduce the yield strength of aluminum. At 300 F most aluminum alloys will have a yield strength about 10 to 50% lower than that at room temperature. Parts such as oil-hardened springs begin to lose strength rapidly above 400 F, but ordinary steel parts are very little affected below 500 or perhaps 600 F. Thus, for stressed parts which will be exposed to relatively high temperatures, particular care must be exercised in choosing the proper alloy.

Endurance Characteristics

It would appear then that, in general, if the ability of the part to carry its maximum static load without bending or breaking were the only criterion, one would find little difficulty in designing the part of aluminum in place of iron or steel. However, at the present stage of automotive design, and especially in passenger car work, a failure due to static overload is very rare. It is much more important for a part to be able to withstand loads considerably less than maximum, but which are repeated a great number of times. The limit of the ability of a material to withstand indefinitely this type of loading is known as its endurance limit, and a comparison of these endurance limits for steel and aluminum will give a truer picture of the relative strength than will a comparison of their yield strengths.

The endurance limit of unheat-treated wrought aluminum varies from somewhat less than half to about three-quarters that of hot rolled 1010 steel, depending upon which alloy is used. Here again cold working will increase the values of the endurance limit of both aluminum and steel, but the previously mentioned ratio will not change materially. In order to make up this difference so that an aluminum part would have the same fatigue life as a similarly shaped mild steel part, it would be necessary to increase the thickness of the material by as much as 45%.

Both sand and permanent mold casting aluminum have endurance limits that are less than half that of cast iron, and equivalent sections would have to be about 50% greater in the case of aluminum. Again, it should be remembered that a great many cast iron sections are thicker than necessary because of foundry limitations, and in such cases it may not be necessary to make the material any thicker in its aluminum counterpart.

On the other hand, die cast aluminum has an endurance limit equal to or slightly higher than our ordinary automotive cast iron. However, there is another factor which must be considered in comparing these two materials. Die cast aluminum, unlike cast iron or sand cast aluminum, is notch-sensitive. It is believed that this notch-sensitivity may exist only when the chilled surface layer of the casting has been broken. If this is true, then at those points in a die casting where, due to machining operations, the skin is broken, a stress concentration problem may arise, and any possible advantage held by the aluminum over cast iron may be more than wiped out. In designing die castings, one must keep this stress concentration possibility in mind, whereas in sand castings of either aluminum or cast iron, no such problem exists.

The matter of ribs and turned-up flanges in designs is also important in considering the relative strength of these two materials. In most cases, these are added to give rigidity to a structure, but one should be careful to proportion them in such a way as not to reduce the strength of the section being stiffened. For example, a section 2 in. wide and 1 in. deep with a rib ¼ in. wide and 1 in. high is about two and a half times as stiff, but only 90% as strong as if the rib were omitted. Such a weakening is particularly noticeable in fatigue loading rather than in static loading where a very slight yield in the material at the outer edge of a rib will redistribute the stress enough to avoid static failure. In dealing with aluminum in which the ratio of endurance limit to yield strength is lower than in steel, care in the proper design of rib proportions is even more important.

Other Considerations

Modulus of Elasticity—There are a number of parts in an automobile in which stiffness is much more of a problem than strength. Such parts as the transmission case, various linkages, and brake parts receive a rather close scrutiny as far as deflection is concerned. The modulus of elasticity of the material from which such parts are made may well be its most important property.

It is rather unfortunate that a material that has as much to recommend its use as has aluminum should have a modulus of elasticity which is only one-third that of steel. Strength deficiencies can be circumvented by the use of heat treatable alloys if circumstances warrant the extra operations involved, but there is no way of getting around a low modulus of elasticity. Therefore, wherever an aluminum part must not deflect any further than its steel coun-

terpart, the depth of section must be increased 45%.

In castings, the aluminum is in much better shape compared to gray iron than is the wrought aluminum versus steel. The modulus of elasticity of cast aluminum is about three-fourths that of the generally used value for cast iron, which indicates a necessary increase in depth of the aluminum section of but 10% over that of cast iron. It is interesting to note the wide variation which exists in the value of the modulus of elasticity of cast iron. Curves give values anywhere from 8,000,000 psi. to 20,000,000 psi., depending upon a number of various factors.

Thermal Expansion— A few parts in the automobile, such as some of the engine, transmission and fluid coupling or torque converter parts, are subject to considerable change in temperature. Inasmuch as the coefficient of thermal expansion of aluminum is about twice that of steel, another factor enters the design picture which must be taken into account and investigated thoroughly. In such locations whenever aluminum parts are bolted together with steel bolts, there is a tendency to thermally stress the parts beyond the yield strength at high temperatures, resulting in a subsequent loose connection at the lower temperatures. This is particularly important if the assembly must be fluid tight. Large steel inserts in aluminum castings are also liable to be loose in some temperature range and must be given close study. Running fits of steel parts mounted in aluminum cases would be seriously affected by temperature change, and this also requires some serious investigation.

Galvanic Corrosion—While on the subject of using steel and aluminum parts in close proximity to each other, there is another design problem which will require some serious consideration. When two dissimilar metals are immersed in a salt solution, a difference in electrical potential exists which causes a small current to flow from one to the other. This electrical flow greatly accelerates the corrosive action of the solution. Joints between aluminum and steel parts which are exposed to the salt water from our winter streets and which are of such a nature as to hold this moisture for any appreciable length of time, are subject to such rapid corrosion. Care should be exercised in the design of such joints to protect them from the salt or from each other. Another potential source of trouble is in engines, when steel or cast iron is close to aluminum parts and both are exposed to the cooling water.

Hardness—The Brinell hardness value of unheat-treated aluminum alloys, which is roughly one-third that of mild steel, will affect at least two types of application of this material in automobiles. First, those moving parts, such as levers and other linkage parts which are exposed to the weather, mud, sand, etc., do not resist wear very well even when made of steel. In a great many cases the rubbing surfaces of such parts are cyanide hardened to make them commercially acceptable. If these parts are to be made of aluminum in which this problem of severe wear cannot be corrected by cyaniding or similar processes, it becomes necessary to resort to hardened steel inserts. This procedure is perfectly feasible from the standpoint of design, but may seriously affect the economic aspects of such a use for aluminum. Hard aluminum surfaces can be obtained by anodizing, but this is done on parts that generally receive plentiful lubrication such as pistons. It is felt that this process will not prevent the severe abrasive wear which I have just mentioned. This low hardness also necessitates the use of steel inserts in threaded holes if service requires more than two or three removals of the screw. Secondly, the exterior parts, which must maintain a good appearance and which are subject to scratches and unsightly corrosion, such as mouldings, hub caps and bumpers, present another type of problem. In steel, this difficulty can be surmounted by the use of chromium plating or stainless steel. Aluminum parts may also be chromium-plated, but whether or not the hardness of the underlying material will seriously affect the life of the chromium plate or not, has not yet been determined. Our experience indicates that if the plating successfully protects the part against corrosion, no difficulty is expected from the softness of the underlying material.

Soldering Is a Problem

Joining—The price and appearance of automobile bodies have reached their present enviable state largely because it is possible to stamp sections or panels and spot weld them together. On the exterior surface, these welds are located in a depression which is later filled with solder so that no joint is visible. While aluminum sections can be so welded together (how readily seems to be a matter of considerable difference in opinion), the use of solder to fill this weld depression and prevent moisture accumulation is not possible at the present time. It will not adhere to the aluminum, and unless some other material can be found which will "stay put" and form a good base for paint, the use of aluminum for exterior body panels seems to be unfeasible. Of course, an entirely new type of joint design might change this picture also.

Weight—The property of aluminum, which more than anything else makes its use attractive is its weight, for it weighs about a third as much as steel. Throughout this paper reference has been made to the amount a section would have to be increased in order to make up for a lower strength or modulus of elasticity. This was all based upon the assumption that the sections were solid rectangles. The increase in volume of material would be considerably more than indicated if the sections were U-shaped or box-shaped and could not be changed appreciably in outside dimensions. For example: increasing the thickness of a plate 10% results in a 21% increase in bending strength, but in order to increase the bending strength of a 2- by 2- by ⅛-in. box section 21%, an increase of almost 25% in wall thickness is required. It has been estimated that the total number of parts that could be changed from steel or cast iron to aluminum would contain about 45% more volume of material, so the resultant weight saving would be approximately one-half.

If the gross weight of cars could be reduced by

A trailer constructed of high-strength aluminum alloys. Design and fabrication follow aircraft production principles. (Courtesy: Fairchild Engine & Airplane Corp.)

only 10% there would be a great number of advantages. There would be a gain in performance, or if the performance was kept the same, a smaller engine, or perhaps a simpler transmission or a faster rear axle and smaller brakes could be used. It would be possible to reduce the size of all the suspension parts, including wheels and tires. Weight saving has a pyramiding effect. The customer would also gain a great deal from such a weight reduction. In most states, he would save a little in the cost of his license plates, he would save on shipping costs, and he would save still more on fuel consumption.

Cost—The resultant 50% weight saving just mentioned means that, assuming all other operations to be the same, aluminum parts would be economically practical if they did not cost more than twice as much per pound as corresponding steel or cast iron parts. To date, this has not been the case. But as stated previously, this price situation can change overnight.

There are some parts that are economical even at the present price of aluminum as compared to the ferrous metals. There are two reasons, either one or both of which could account for this. Cast iron parts which carry practically no load are generally a lot heavier than their function requires. These could be replaced with thin walled die castings whose weight might be only one-fifth that of the iron parts they replace, thus allowing a pound price of aluminum five times as great as iron. An important factor in this cost of castings is that the cost of processing the basic metal in the foundry is much less in the case of die casting or partially automatic permanent mold casting than is possible with sand casting. Then, too, a number of small parts can be designed as die castings to eliminate practically all the machining which the present steel or cast iron parts require. This elimination of the necessity for machine tools and also the labor required to handle the part and perform the machining operation would make up for considerable difference in initial material cost.

In conclusion, from the standpoint of design, it is probable that in time aluminum, steel and cast iron will each be used in those places in a car for which it is best suited. As time goes on, manufacturing techniques will be improved to such an extent that when adopted generally, aluminum may come in for a larger share of automotive use.

A cross section of a semi-finished metal surface having a roughness of 125 microinches R.M.S. (250X).

Accepted standards and measuring methods are taking much of the guesswork out of the question: "How smooth must a surface be?"

Control of Surface Finish Improves Quality, Cuts Cost

by H. R. CLAUSER, Associate Editor, Materials & Methods

SURFACE FINISH QUALITY often has as much, and sometimes more bearing upon the service performance and cost of a product as such things as material composition and mechanical properties. It is reasonable then that in the design and production of a product that careful attention be paid to the selection and control of surface finish. However, despite its evident importance it is often neglected or given perfunctory consideration. There are still many who merely specify the finish desired in terms of a processing operation such as "ground," or "machined."

Failure to give proper consideration to surface finish quality has in the past been due largely to lack of knowledge, standards, and measuring methods. However, in recent years a number of these shortcomings have been corrected. Various instruments and devices for measuring surface roughness have been introduced and surface finish standards have been established. These developments have done much to increase the interest in surface finish. Our purpose here is to describe the basic characteristics of surface finish and also to discuss how product quality can be improved and costs cut through proper selection and control of surface finish.

Surface Finish Characteristics

The structure and characteristics of metal surfaces are quite complex and a complete discussion of surface finish would have to cover a great many things, including surface qualities such as color and luster, corrosion resistance, hardness, and absorption characteristics. But here we will be concerned with only the geometrical aspects of surface finish. To explain these geometrical characteristics, we will follow closely the new American Standards Association's standard on surface roughness, waviness and lay.

Perhaps the best known characteristic of surface finish is *roughness*. Roughness refers to the relatively finely spaced surface irregularities, or scratches, that usually result from the machining, cutting, abrading or forming action of metal working tools. A magnified profile section of a machined metal surface, for example, shows up as a configuration of peaks and valleys. Thus, if the roughness is to be described completely, both the height and width of the irregularities must be considered. At present, however, the roughness is usually designated in terms of the peak-to-valley height in millionths of an inch (microinches). There are a number of possible ways of expressing this. Among those most commonly encountered are maximum peak-to-valley height, average peak-to-valley height, and the deviation from the mean surface expressed as the root mean square (R.M.S.) average.

Various surface irregularities, such as scores, cracks or holes, which occur at one place or at relatively

Checking the surface finish on a Kingsbury thrust bearing. The roughness was improved from about 50 to 8 microinches R.M.S. (Courtesy: Westinghouse Electric Manufacturing Co.)

infrequent intervals, do not enter into the consideration of roughness. They can usually be checked by visual examination and are treated as surface flaws or defects.

It should be pointed out here that a high surface polish often hides the true surface roughness. A surface with a mirror-like finish may be actually rougher under the thin polished layer than a glossless matlike surface. In the polishing operation, the peaks are merely laid over the roughness, hiding scratches and tool marks under the thin film of polish. Although such polished surfaces may be desirable for appearance, they add nothing to surfaces subject to wear or stresses.

The surface irregularities, which are of greater spacing than the roughness, define the *waviness* of the surface finish. On machined surfaces waviness usually results from such things as machine or work deflection and vibration. Since the distance between the crests and troughs of the waves are relatively long, waviness can be detected and measured in inches with conventional measuring devices.

A third characteristic of surface finish is *lay* or *scratch pattern*. This refers to the direction and pattern of the roughness and waviness. It is generally visible to the eye.

The relative importance of each of these characteristics largely depends upon the use made of the surface. For example, in tools such as forming punches, the waviness is often a very critical factor. Even though the punch may have a low roughness value, the inner wall of the part being formed will, under pressure, conform to any waviness present on the punch's surface. Then, as the punch is being withdrawn, this waviness can result in heavy metal-to-metal contact between the punch and the part and cause excessive wear of the punch and perhaps scoring of the part.

In other cases the lay may be of great importance. For example, on shaft bearings it is generally considered good practice to have the roughness and waviness run lengthwise along the bearing; on lathe beds the lay should run across the direction of carriage travel. Thus, where metal-to-metal contact is likely to be encountered, it is believed that cross direction scratches break up the continuity of any welds that might be formed.

To further illustrate the significance of these three characteristics of surface finish, it might be well to follow through a case in which all three must be considered for optimum life and performance of the product. As an example, we will take a common piston and piston rod that fits into a cylinder assembly.

In this assembly the piston rod slides through a packing gland of a relatively soft material and, therefore, must have a very low roughness. But a very low roughness is not enough. For optimum perform-

Surface roughness can be quickly checked with surface finish specimen blocks, as is being done here on a large shaft. (Courtesy: General Electric Co.)

ance it must also have a lay or scratch pattern in the direction of motion—that is, along the length of the piston instead of around it. Should the scratch pattern be across the direction of motion, the piston rod could act as a file on the soft packing and more rapidly cause a breakdown of the packing.

The piston, too, must have a low roughness on its bearing surface, but it probably is not as critical as that of the rod if the piston is always well lubricated and slides against a smooth cylinder wall. The waviness of the piston bearing surface must also be considered, for it largely determines the amount of bearing area presented to the cylinder wall. If the waviness is excessive, there will be surface projections that may cause seizing and galling.

The lay of the finish of the piston also must be considered in relation to the lay of the cylinder wall. Contrary to what might be expected, the lay of the piston surface finish should be such that it runs opposite to that of the cylinder wall. That is, if the lay of the cylinder wall runs around, and across the direction of motion, then the scratch pattern of the piston should be along the piston's length.

The faces or ends of this piston contact only hydraulic fluid or steam perhaps; therefore, they need not be any smoother than that resulting from normal machining practice. Thus, in this example it is evident that by careful selection of surface quality, finishing costs can possibly be cut on non-critical surfaces. If desired, at least some of the savings can be applied toward getting an optimum finish for improved quality and life on the critical surfaces.

Surface Finish Control Improves Quality

As has already been indicated, one of the chief reasons for carefully selecting and controlling surface finish is to improve service quality of the product. There are any number of service functioning characteristics and mechanical and physical properties that can be affected by the quality of surface finish. In moving parts such things as abrasion, lubrication, fit, sliding action, bearing qualities and leakage may be improved or hampered by the particular surface finish selected. Fatigue strength, notch sensitivity, load carrying capacity, heat transmission and optical properties are some of the mechanical and physical properties that can be affected. In addition, if the part is to be plated or painted, surface finish quality can influence the adhesion and appearance of the coating.

Experience in the automotive field has shown that finer finishes combined with close tolerances increase the life of automobile engines. Formerly, careful breaking-in of the engine was required because of the relatively rough surface finish on parts such as the bearings and piston rings. This breaking-in period left abrasive particles in the lubricating stream and increased the wear of parts so that bearings and piston rings usually had to be replaced after 20,000 to 25,000 miles. The present practice of using honed or lapped surfaces and closer tolerances has practically eliminated the breaking-in period and has lengthened the life to at least 50,000 miles and higher in the life of many parts.

This initial breaking-in period is an important factor in the life of a great many moving mechanical parts. The use of finer finishes in such parts is really a substitute for the wearing-in process before final assembly. This permits the use of more efficient clearances, better lubrication of surfaces at starting and stopping, and reduced turbulence in lubrication during operation which, in turn, reduce power losses and operating temperatures and increase wear life.

Frequently, to obtain a finer surface finish it is necessary to make changes in several processing methods as well as in the material. For example, in the manufacture of a large Kingsbury thrust bearing, ways were sought to improve surface finish and thereby improve its bearing performance. After careful study, the composition of the bearing metal and the casting method were changed; in addition, various methods of machining and finishing were observed to arrive at the most economical method of producing an optimum finish. The result of this program was that the surface roughness was improved from a range of 50 to 63 microinches R.M.S. to between 6 and 8 microinches R.M.S., and finishing time was reduced by about 50%.

In case of cutting tools, it is well known that a smooth finish on the cutting edge greatly increases the life of the tool. With a honed finish, for example, a tool removes more metal per cut; the tool also has

a longer over-all tool life, and produces smoother surfaces. Improvements in tool life have been reported to be on the order of 30 to 400%.

Fine, smooth finishes and improved quality do not necessarily go hand-in-hand. Although it is true that in many parts a smoother finish results in a better performance, the opposite is also frequently true. For example, in one particular case a grit blasted journal was compared with a ground and polished one of ⅓ the roughness and was found to have three times the load carrying capacity without any tendency to seize. In other cases, tests showed that steel shafts with a sprayed metal coating, having a porous surface, had better bearing performance than smoother and hardened steel shafts. On the other hand, tests conducted on a set of journals showed that by decreasing the roughness of the hardened and ground journal surface from 10 to 12 microinches to 2 microinches the load carrying capacity increased from an average of 1625 psi. to 2700 psi.

Cost Reduction Through Surface Quality Control

In general, it may be said that a rough surface is cheaper to produce than a smooth one. Just as costs rise sharply when dimensional tolerances are reduced, so costs increase when fine finishes are involved. Therefore, it is poor economy to make a surface smoother than is required for the proper functioning and satisfactory service life of the product. However, there are some instances where the most economical method of production happens to produce a smoother surface than is required. In these cases an extra smooth surface is, of course, justifiable if performance of the part is not adversely affected. Another exception is where it is cheaper to finish a surface at the same time as an adjacent surface that requires greater smoothness.

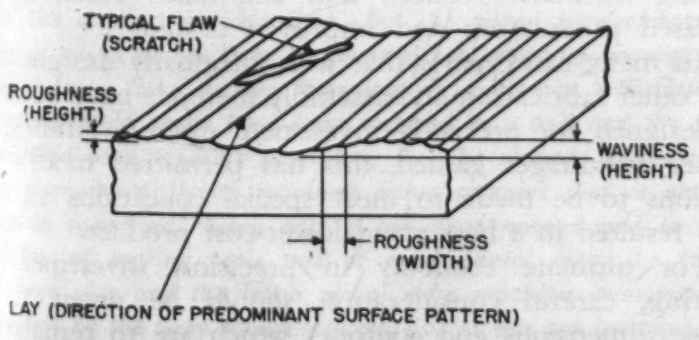
Any number of examples could be cited in which proper selection and control of surface finish quality resulted in significant savings. In one case a manufacturer of a certain bearing used in a gyro mechanism found that a surface roughness of 8 microinches R.M.S. was amply satisfactory for proper functioning of the part; whereas they were being finished to a value of 2 microinches. By finishing to the higher roughness value, it was possible to eliminate a lapping step, which was one of the most costly of the manufacturing processes.

A typical example of how savings can be made by careful surface quality control is the experience of an electrical manufacturing company in finishing motor journals. A check of all finishes on a production run of journals revealed that the roughness varied from 10 to 65 microinches R.M.S. After an investigation it was found that a roughness of 35 microinches gave the best results. The 10 microinch finish was not only more costly to produce, but also gave poorer performance, because it did not satisfactorily carry the lubrication. Therefore, the quality control range of around 35 microinches was established.

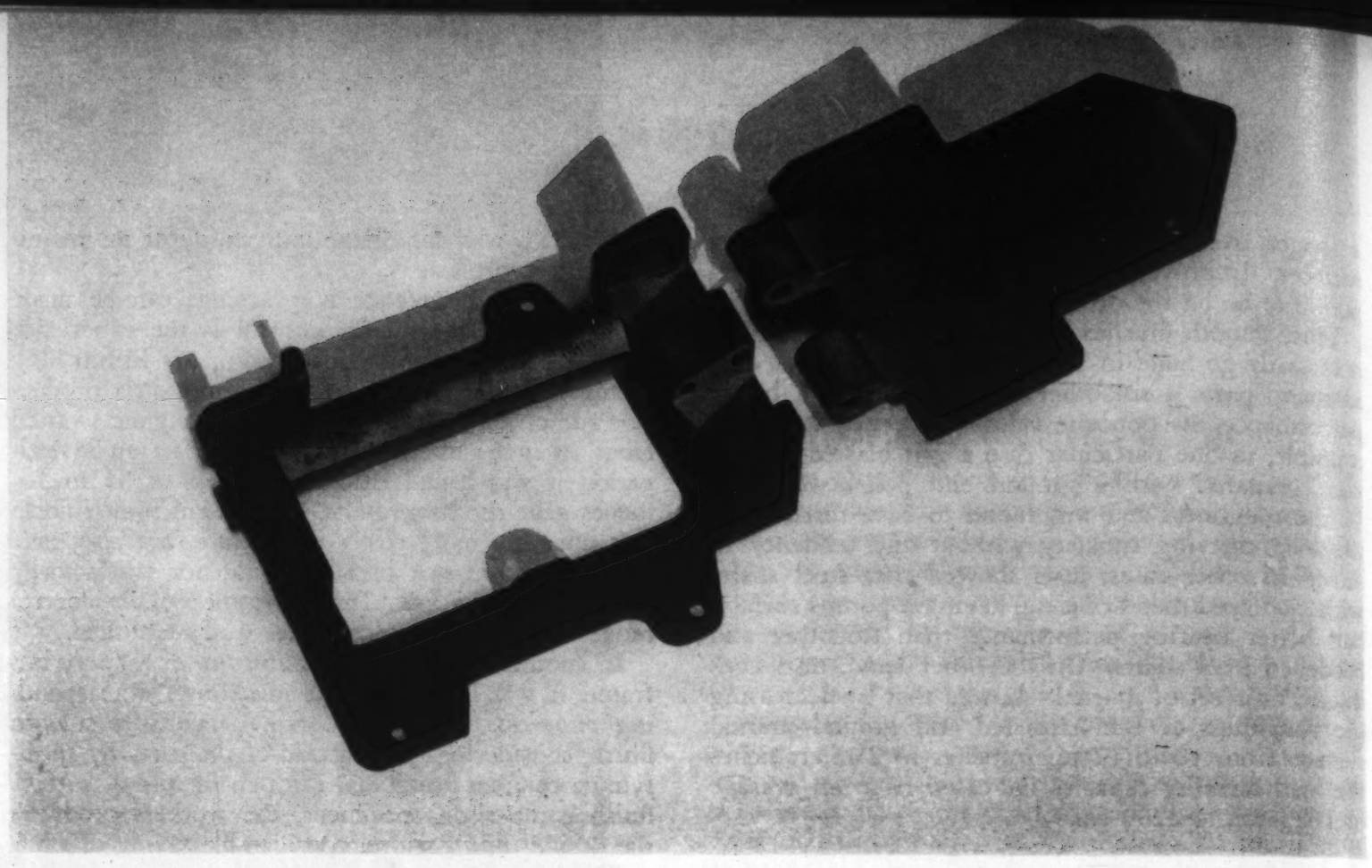
In another case, in the manufacture of a heavy bus frame, it was found that the machinists were spending unnecessary time to obtain a relatively smooth finish, considering the function of the part. By specifying a rougher finish, and through the use of surface finish comparison specimens, the workers produced the desired finish with a considerable saving of time.

Where the lay and waviness of the finish are not particularly important it is often possible to reduce costs by merely specifying the required roughness, and then allowing the production department to obtain that roughness by the most efficient method. Instead of specifying that a hole be bored, for example, the roughness desired on the interior surface can be merely indicated; the hole can then be made by drilling, reaming, broaching, or any other suitable method as long as the surface roughness requirement is met. Or, if it is faster and cheaper to lap a given part rather than grind it, the production department has the freedom to select the more efficient process. By specifying the surface roughness instead of the finishing method, it is often possible to eliminate machining or finishing steps where forming processes are available to produce a part with the required smoothness. For example, there may be instances in which a high quality casting or a cold forging could be used to produce the part to finish dimensions and specified roughness without any further machining or finishing. However, when lay and/or waviness of the surface must be considered, it is usually not enough to just specify roughness, for waviness and lay vary widely according to the processing method used.

In conclusion, it should be recognized that there is still much to be learned about surface finish quality. A large amount of study and investigation is still required before engineers will have available data and specifications on which to base the selection of finishes for parts under any service conditions. Therefore, each surface finish case must be considered in the light of its own particular circumstances. Because of the lack of concrete data, the subject of surface finish quality has a number of controversial aspects. And there is still some confusion on matters of nomenclature, standards, and measuring methods. However, there is agreement on one point at least; and that is, that surface finish quality is an important factor in the performance and life of many metal parts. And because of its recognized importance, research by industry is proceeding to learn more about the relationship of surface finish quality and various performance properties.



Schematic sketch showing the various characteristics of a surface finish. (Courtesy: American Standards Association.)



1 *The five main components of a Latham time clock hinge originally included two stampings and three machined parts. Now all five parts are precision investment cast in bronze by the Arwood Precision Casting Corp. In as-cast condition, the smoothly-moving fits and accurate alignment obviate further finishing operations. The addition of hinge pins and springs complete the assembly. Ten different keys per station, also of bronze, are precision investment cast as individual members and are ready for use without finishing operations.*

Precision Investment Castings Reduce Assembly Operations

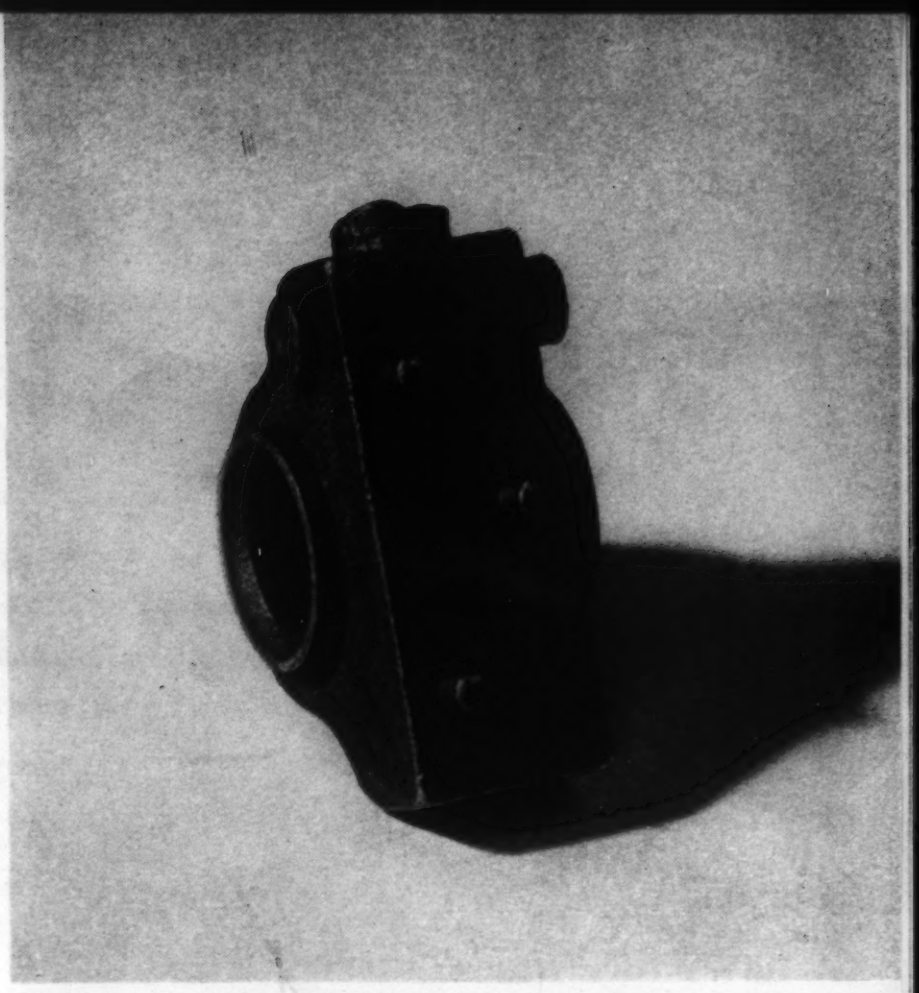
by EDWIN LAIRD CADY

Seven examples that show how precision investment castings reduce costs, speed production, and improve product design.

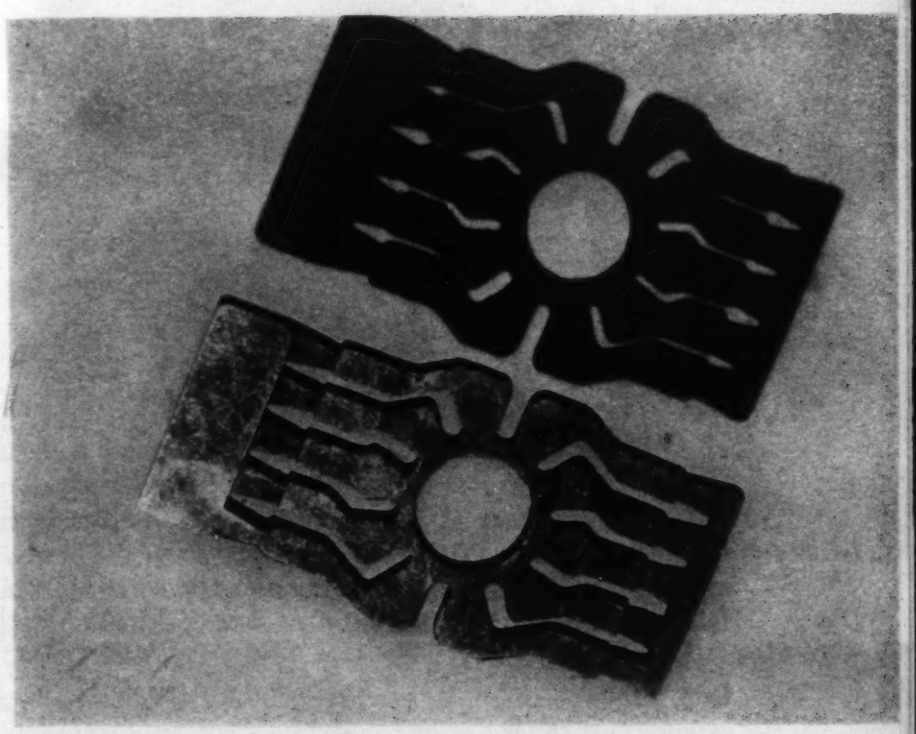
ASSEMBLIES OF SEVERAL PARTS frequently can be produced as single integral units by precision investment casting. This technique supplants the welding, brazing, soldering, force fits, upsetting, and other joining methods previously used. Major advantages of this unitizing are: Drastic reduction of assembly costs; increased strength and durability; use of alloys impractical for previous assembly or fabricating methods: reduced tool and labor costs; increased production; and improved design.

In many cases, parts that were originally designed for other fabrication and assembly methods have been redesigned for precision investment casting. Among other advantages gained, this has permitted modifications to be made to meet special conditions and has resulted in a better and lower-cost product.

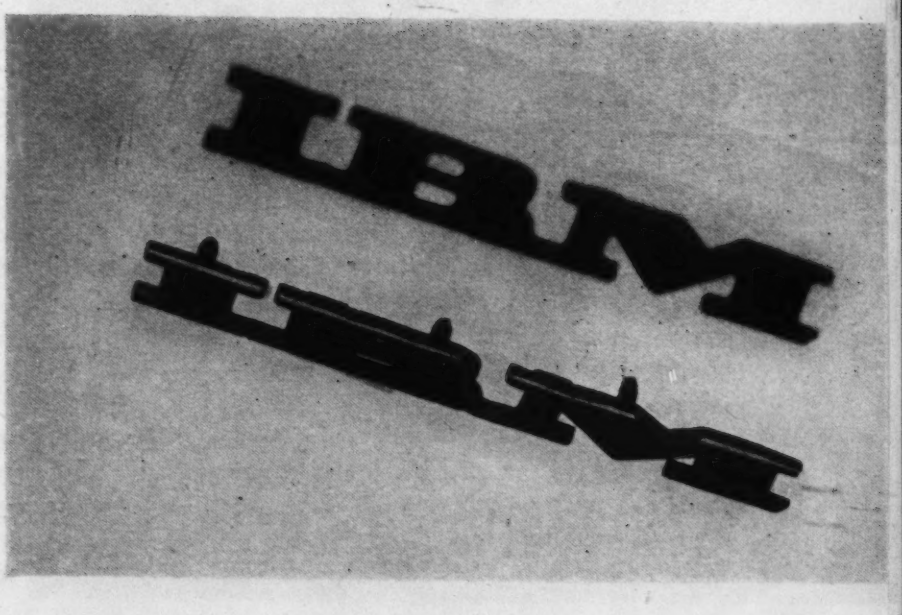
For ultimate economy in precision investment casting, careful consideration should be given to those dimensions and contours which are to remain as cast and to those which are to be finished by secondary operations.



2 *This small pillow block is fastened to its support by the upset riveting of three bosses protruding from the bottom of its base. The block is required to have two bosses with special end contours parallel to the bearing bore. As originally designed, the block was constructed of six parts: 3 rivets; 1 main body; 1 bearing sleeve; and 1 boss pin contoured on both ends. The original production and assembly operations were: (1) Cast main body, drill for bearing sleeve and boss pin, machine bottom parallel with bearing, and drill three blind holes for rivets; (2) machine bearing sleeve and chamfer inside edge of one end; (3) machine boss pin and mill both ends; (4) cut off rivets to length from rivet wire; (5) force-fit bearing sleeve in place; (6) force-fit boss pin in place; and (7) force-fit rivets into block. When precision investment cast in manganese bronze by the the Gray Manufacturing Co., the operations were reduced to: (1) Cast entire piece; (2) grind off gate; (3) ream bearing bore; and (4) mill ends of bosses which are parallel with bearing bore. A further saving resulted from the reduced inventory costs of keeping parts for the assembly on the stock shelves.*

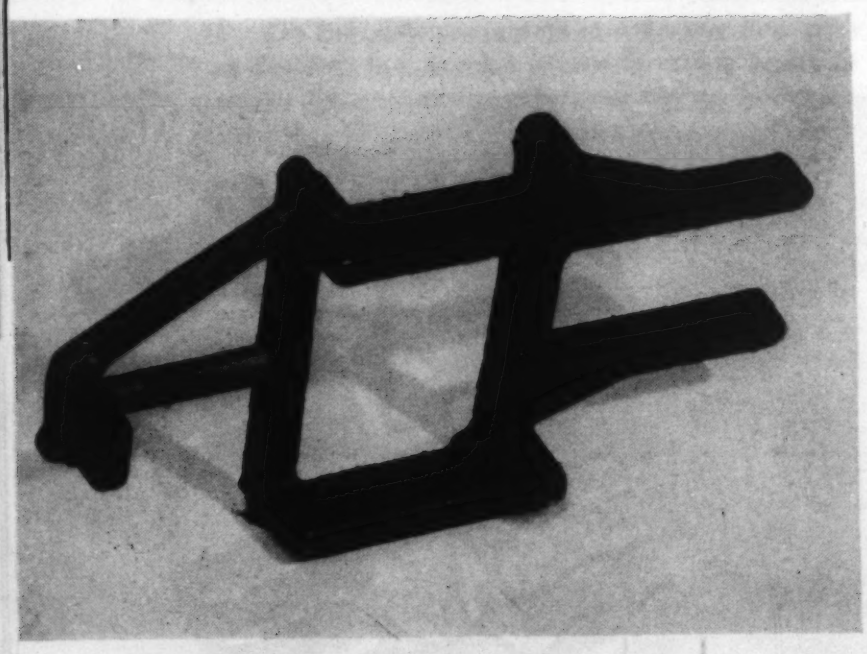


3 *These electrical contacts are precision investment cast in both stainless steel and beryllium copper by the Gray Manufacturing Co. Plates of this type are stacked between layers of plastic material and heat and pressure applied. With the "sandwich" solidified as a unit, the center is drilled out and the ends cut off. This leaves the points individually insulated in the plastic block. Prior to the adoption of precision investment casting, an attempt was made to stamp out the points for each layer, the points being unitized by excess metal at the ends and at the center. This resulted in a difficult and costly stamping problem, particularly for such alloys as 302 stainless and beryllium copper. Since the widths of the slots to be stamped were less than the thickness of the metal, serious die trouble developed at the punch presses. Another futile attempt, prior to the adoption of precision investment casting, consisted of stamping out individual points, fixturing them in a mold, and pouring molten plastic. This proved impractical from both a tools cost and plastic setting standpoint.*



4 *This simple, stainless steel, three-letter nameplate was required in the shortest possible time. But the added requirements that all outer edges on the face be rounded for better appearance and that each letter have its own fastening pin, presented difficulties. These letters could easily have been stamped as a unit and the three pins applied as a separate operation. But the rounded edges constituted a stamping difficulty requiring either complex dies or another separate operation. Since only a few were needed and to avoid the delay of making tools and of experimental runs, the four pieces (three pins and the letter piece) were precision investment cast as a unit by the Gray Manufacturing Co. It was not intended that precision casting would be used on longer runs. Stamping and subsequent assembling would be less costly on these.*

5 *Pliers were wanted in either 1020 or 4651 steel, with blades specially contoured for crimping contacts. Ends of the handles were to have prongs at right angles to their lengths. The prongs on one handle so machined as to be "go" gages for the crimps; the prongs on the other handle to be the "no-go" gage. Thus, the same tool would make and inspect the crimp. It would have been entirely feasible to drop forge the prongs with the handles or else to generate solid sections from which the prongs might be milled. It would also have been possible to make the prong sections as separate pieces and weld them to the handle ends. But precision investment casting by the Gray Manufacturing Co. proved to be the least expensive method. Especially in view of the fact that all slots and the holes for the hinge pins could be accurately cast in, thus eliminating costly secondary finishing operations.*



6 *This intermittent motion piece, designed to operate with minimum backlash, is actuated by a pair of cams in the rectangular midsection. A third cam, synchronized with the center two, causes actuation within the end prongs. As originally planned, this three-cam follower required: 1 prong-end stamping; 2 longitudinal flat bar follower stampings; 1 transverse flat bar stamping; 2 round wire longitudinal connecting bars; and 1 flat upright or lug stamping. After welding, the assembly required machining and grinding to final dimensions. Instead, all seven pieces are now precision investment cast as a single unit by the Gray Manufacturing Co. Secondary finishing operations, although similar to those needed for the assembled type, are considerably fewer and lower in cost. As an additional advantage, the casting has narrow rib fillets to stiffen and reinforce the prongs.*

7 *Five stamped or machined cams were formerly bolted, pinned, or otherwise joined to a steel plate to form the cam path for a knitting machine needle action. This involved a difficult assembling operation and a costly production of parts. Furthermore, with this construction, only eight feeds or completed cycles of knitting operation were practical for a 15-in. machine. Single cam paths, precision investment cast of SAE 1020 steel by the Edmos Precision Casting Corp., now replace the five former cams. These cast cams are placed radially around the dial plate, the needles passing from cam to cam. Instead of the former eight feeds for a 15-in. machine, the new camming permits 15. One key surface is cast 1/16-in. oversize and is straddle-milled to fit a slot in the holding device. The front face is surface ground. The cam path is cast so accurately that a dimension of 0.125 in., plus 0.005 minus 0.000, as measured radially from the center of the machine is maintained as cast to finished size. The cams are carburized 0.0300 in. deep and water quenched to a minimum Rockwell A hardness of 82.5.*

Strong films of many types are formed by water dispersions of synthetics without the need for special equipment and solvents.

Unplasticized Vinyl Latices Are Versatile Coatings

by **JAMES L. FOSTER,** Technical Service Engineer, B. F. Goodrich Chemical Co.

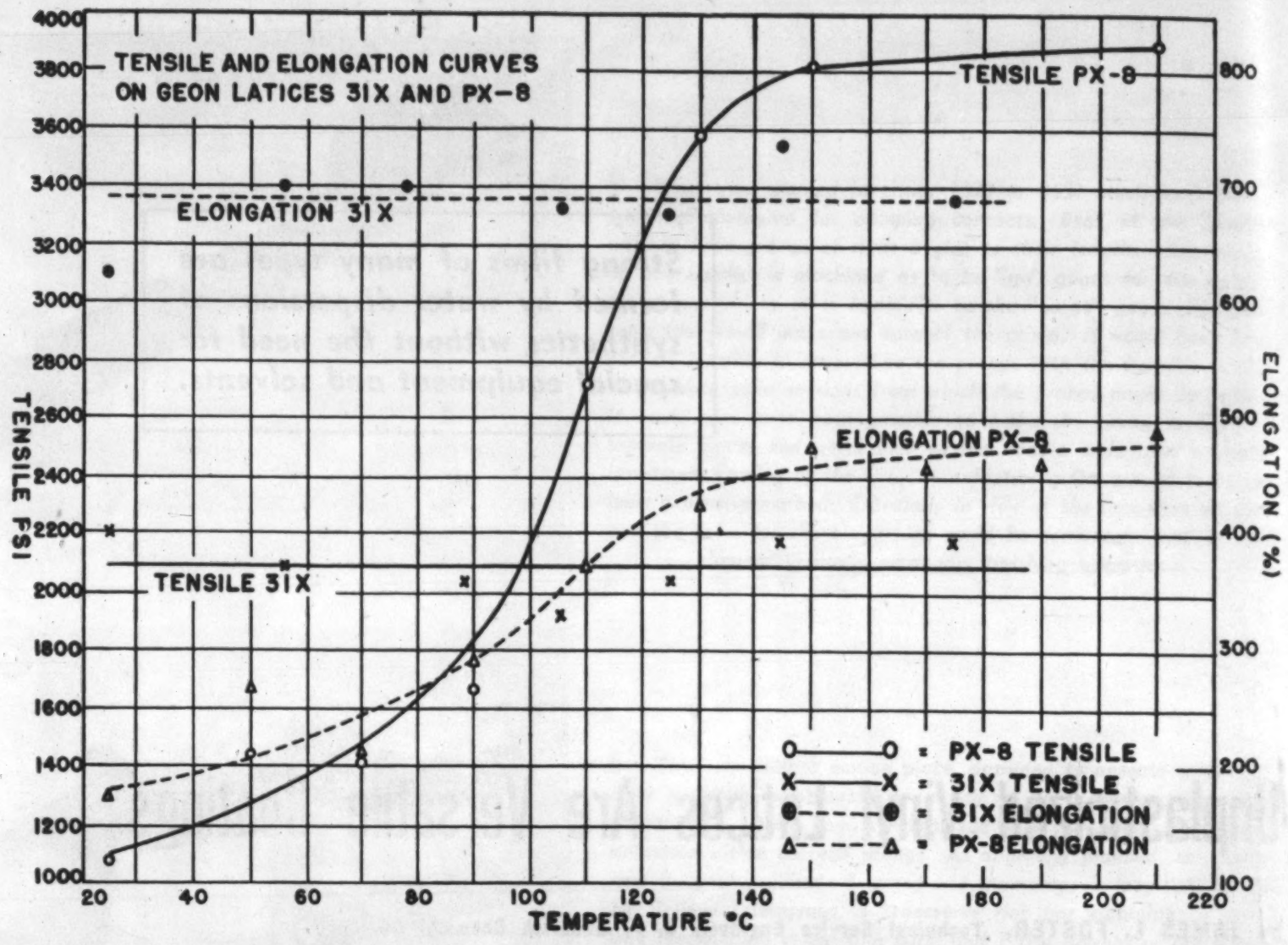
THE DISPERSION OF TINY GLOBULES of natural rubber in the watery fluid of such plants as the rubber tree is called a latex. Because of its valuable properties, natural rubber latex is an important article of commerce, as well as the other forms of rubber. Industry has found many uses for these water dispersions of materials usually thought of as completely incompatible with water; they provided an easy means of mixing water-soluble materials with these incompatibles, otherwise difficult to mix; they became excellent adhesives for many types of porous materials; foamed rubbers were prepared from them.

With the introduction of synthetic rubbers, for which there could be no natural latex, artificial dispersions of the rubbery material in water were prepared so that the attributes of latex could be obtained with the synthetics also. These were called artificial latices, and they too are now standard materials of industry.

Certain of the vinyls possess elastomeric properties. Recognizing the value to industry of having these important synthetics available in latex form, the B. F. Goodrich Chemical Co. developed water dispersions of its trademarked vinyl chloride polymer, Geon, in the unplasticized and plasticized conditions, and in combination with its trademarked acrylonitrile synthetic rubber, Hycar. The most recent of these, Geon Latex 31X, is especially interesting because it forms strong films on many kinds of material by simple room-temperature drying, without use of plasticizers. It possesses other properties that are receiving consideration from industry, such as its ready adhesion to a wide variety of materials, its adaptability to strippable coatings, and its value as a packaging material for foods.

The vinyl latex as offered to industry is a colloidal dispersion in water, with about 55% total solids. It is quite stable, but is subject to deterioration by such conditions as freezing cold, as are all latices. Temperatures of about 60 F cause some thickening of the Geon latex 31X dispersion, and the resin shows a tendency to settle. Lowering the temperature to about 40 F makes the lower layers of the dispersion become semi-solid. The dispersion is not broken, however, and warming to normal temperatures will restore the latex to its original condition. Freezing temperatures will cause coagulation.

Prolonged storage has little deleterious effect upon the dispersion. The material may tend to become very slightly acid, as shown by an insignificant drop in the pH value, but the stability of the dispersion is not appreciably lessened. A little alkali, sodium bicarbonate or carbonate may be added if the pH value goes lower than 7.0. It is usually 7.0 to 8.5. Because of the composition of the 31X latex system, the use of ammonia should be avoided. With the other Geon



The properties of Geon Latice 31X, shown on these curves, show this material to be remarkably stable over a wide temperature range.

latex dispersions, the pH should be maintained between 8.0 and 9.5 during storage. With these systems, the use of ammonia as the buffing agent is satisfactory.

The new vinyl latex compares with several of the vinyl dispersions already known to industry as follows:

	(31X)	(11X)	Plasticized (11X)
Specific Gravity	1.25	1.165-1.180	1.120-1.130
Total Solids	50-55%	52-55%	55%
Viscosity (Centipoises)	10-20	10-20	10-20
pH	7-8.5	8-9.5	8-9.5
Color	White	White	White
Stability	Good	Good	Good

Films, supported and unsupported, can be prepared from the latex, and frequently with very simple equipment. There is no complicated solvent evaporation or solvent recovery system needed, as the dispersion uses nothing but water in its continuous phase. The only treatment which the latex is customarily given in preparation for coating or forming of unsupported films is a thickening of the dispersion, which reduces the tendency to form shrinkage patterns upon the part of the drying film also but reduces flow and impregnation properties. The thickening is readily accomplished by adding 0.2 to 0.5% of hydroxy ethyl cellulose, or the same percentage of the sodium salt of carboxy methyl cellulose. Percentage is calculated upon the weight of dry solids in the latex.

As the latex is a dispersion of tiny particles of the resin in water, pigments, platicizers, and other ingredients may be mixed uniformly through the dispersion if added as dispersions in water also. To prevent coagulation, the dispersions of the auxiliary ingredients should be slightly alkaline in reaction, with a pH of about 7.0 to 9.0 for the 31X formulation.

When coagulation is a part of the film-forming process, as in the anode dipping process, a mixture of the new vinyl latex and the dispersion of nitrile rubber listed by B. F. Goodrich Chemical Co. as Hycar OR-25 latex should be used. Vinyl polymer may form from 10 to 80% of the mixture. The resulting film will be flexible when the synthetic rubber content is at or near the 20% end of the range, with elasticity increasing toward the 90%-rubber composition. Neither the vinyl nor the synthetic rubber gives a cohesive deposit when used alone in the coagulant bath.

For many purposes—in food packaging, for example—the presence of large amounts of plasticizer in the vinyl formulation is objectionable. The flammability of the sheet stock is largely dependent upon the kind and amount of plasticizer used, also. Films can be produced from the new vinyl latex that are completely free from plasticizer, and so are acceptable for wrapping foods. These films will not support combustion.

Forming of unsupported films may be done very simply with the water dispersion of vinyl polymer by casting. By spreading the latex onto a smooth metal plate, drying at room temperature, and then fusing the residual coating at moderate temperatures and stripping from the plate, a flexible film of unplasticized resin is obtained. This method has produced sheets of from 1 to 4 mils in thickness. The ability to produce films by simple room-temperature drying, and without the use of plasticizer, is a special feature of the new latex, 31X.

Unsupported films show good tear resistance. Resistance to deterioration by heat and ultra-violet light is slightly better in the older dispersions than in the new vinyl latex.

Coatings may be applied to many types of sheets and fabrics, and both laboratory tests and results of experience in the field have been very satisfactory. When applied to paper, the unplasticized vinyl polymer coating confers properties of especial value in the packaging of food. Some of these are:

(1) *High moisture resistance.* The film is an excellent moisture barrier, and so prevents drying-out of moist foods, and loss of crispness in certain types of baked goods. Materials which must be kept dry are likewise adequately protected by packages of 31X latex coated papers.

(2) *Greaseproof qualities.* Of importance in the wrapping of meat or lard, resistance to penetration by grease widens the field of usefulness of the coating.

(3). *Heat sealing.* Coating of paper with the latex makes the paper heat sealable.

(4) *Printable.* The coated stock may be printed with special inks, such as are used for printing on the vinyl plastics.

(5) *Good low-temperature flexibility.* This property is of value in the protection of refrigerated foods.

(6) *Tasteless, odorless.* Closely associated with the absence of a plasticizer, the ability to remain in contact with foodstuffs without imparting taste or odor is of the utmost importance in selecting a material as a food wrapper.

(7) *Moderate cost.* Paper coated with the vinyl resin by use of the new latex is priced competitively with aluminum foil.

When used as a coating, vinyls applied from latices retain their flexibility at low temperatures. It is interesting to note that the unsupported films do not possess this property. Results of tests show the following:

Coating on kraft paper, 0.001 in. thick—flexible at -70 F

Coating on glass fibers, 0.002 to 0.003 in. thick—flexible at -70 F

Coating on balloon cloth, 0.002 to 0.003 in. thick—flexible at -70 F

Unsupported film, 0.004 in. thick, flexible at +20 F

Unsupported film, 0.004 in. thick, failed at +10 F

Flexibility was determined by creasing the coated materials or the films at the indicated temperatures.

The vinyl film prepared from latex possesses excellent adhesion to a variety of materials. It bonds readily to wood, and is now being tried for the manufacture of waterproof plywood. It has been suggested for the cloth backing industry, in which a decorative fabric is fastened by adhesive bonding to a stronger, coarser cloth, or to leather, etc. In joining such absorbent materials, the vinyl latex acts without heat or pressure, and is very rapid in forming the bond.

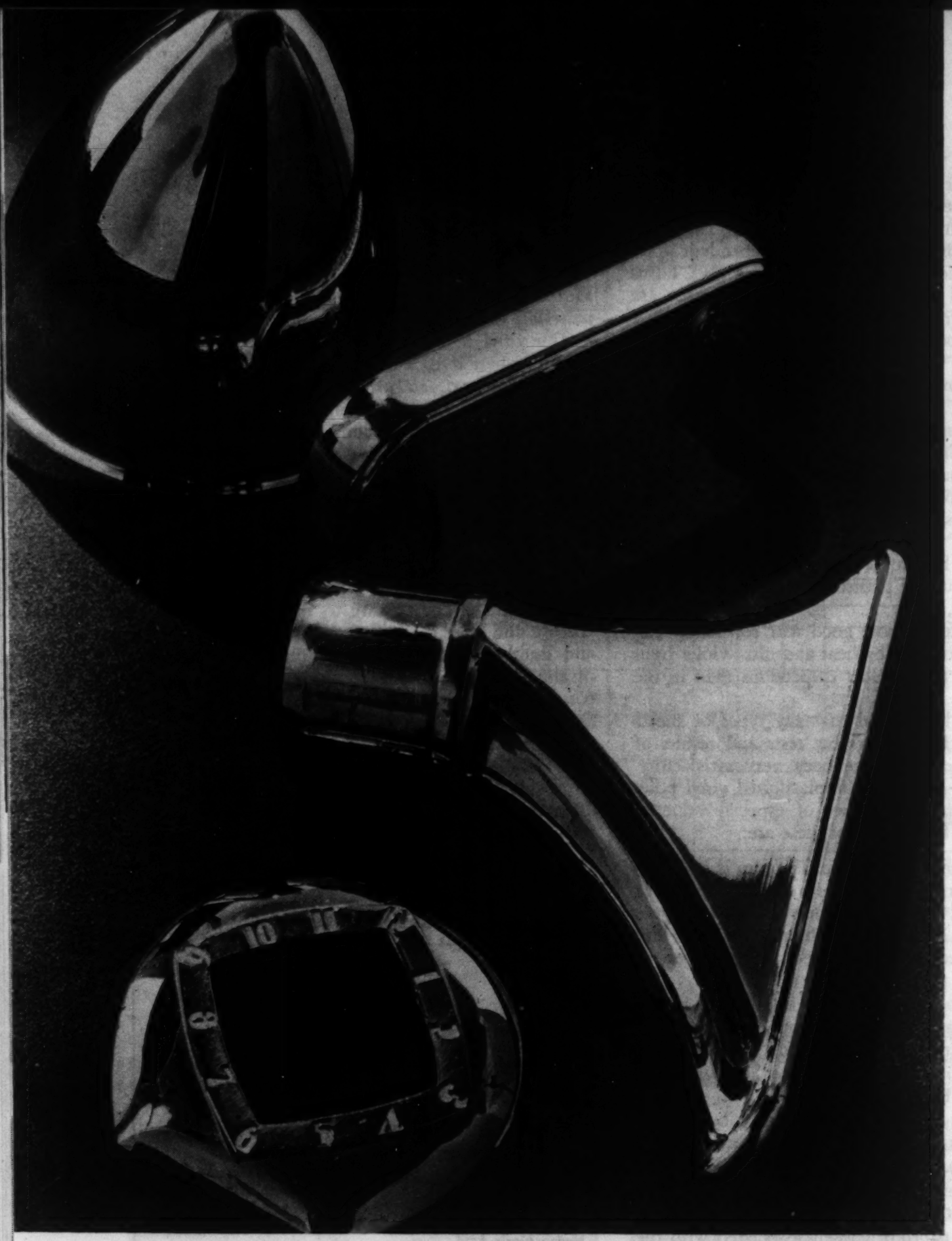
A water-impervious film can be deposited on timbers by simple brushing or spraying with the latex, and permitting the coating to dry in the air. As a coating and filler for leather, it can improve strength and durability and permit printing and embossing of the surface. It has been suggested as a nonskid coating for the under side of rugs laid on varnished floors.

When applied as a coating over metals, the vinyl film does not adhere tightly, but instead forms a strippable coating. The fact that the latex is a water dispersion may retard its application to coating ferrous metals, but it seems to have a field in the coating of nonferrous metals and alloys.

Chemical Resistance of 31X Films

Chemicals	% Wt. Gained or Lost After 7 Days Immersion	Appearance of Film After 7 Days Immersion
Distilled Water	+32%	White, opaque, stiff
Sodium Chloride, 10%	+ 8	White, opaque, stiff
Sodium Hydroxide, 1%	+14	White, opaque, stiff
Sodium Hydroxide, 10%	+ 7	White, opaque, stiff
Ammonium Hydroxide, 10%	+44	Yellow, opaque, stiff
Sulfuric Acid, 3%	+13	White, opaque, stiff
Sulfuric Acid, 30%	+ 3	White, opaque, stiff
Nitric Acid, 10%	+ 8	White, opaque, stiff
Hydrochloric Acid, 10%	+ 5	White, opaque, stiff
Ethyl Alcohol, 95%	+13	Slightly yellow, opaque, stiff
Ethyl Alcohol, 50%	+34	White, opaque, stiff
Ethyl Acetate	—	Completely dissolved
Carbon Tetrachloride	+79	White, opaque
Acetone	—	Film disintegrated
Methyl Ethyl Ketone	—	Completely dissolved
Methyl Isobutyl Ketone	—	Completely dissolved
Heptane	+ 4	Cloudy
Toluene	—	Mostly dissolved
SR-6 Gasoline (40% Aromatics—60% Diisobutylene)	+28	Pink, opaque, stiff
SR-10 Gasoline (Diisobutylene)	+ 2	Slightly pink
Motor Oil SAE 40	+ 1	Slightly green

Note: All film samples which gained weight without dissolving lost this weight again on standing seven more days at room temperature, after the immersion treatment.



Chromium applied over nickel-plated aluminum gives a permanent nontarnishable finish to these utensils. (Photo: Courtesy Aluminum Co. of America)

Electroplating on Aluminum Extends Use of This Material

by HAROLD A. KNIGHT

Plating on aluminum is desirable for many reasons, although most plated surfaces are applied to achieve different surface appearances.

PLATING OF OTHER METALS on aluminum is virtually as old as the commercial use of aluminum itself. An English patent on nickel plating of aluminum was issued in 1888, the year the first commercial production of the metal was started in the United States. Since then, until recent years, interest in electroplating on aluminum and its alloys has been spotty. Last year showed a marked gain in the use of nickel plated on aluminum. The present widespread interest is the result largely of shortages in competitive materials, the relative price of competitive metals, and development of satisfactory plating techniques.

However, there are inherent advantages of plated aluminum that will persevere long after steel and other shortages disappear. There are three main advantages over plated steel. One is obviously lightness, another easy workability and the third, availability. It is much easier to develop a highly buffed finish on aluminum than upon steel. Even deep scratches can be removed from aluminum, whereas removal of such scratches from steel would be costly.

Usually plating on aluminum is not applied for protection but for finish effect, or some more obscure reason, such as to form a bond between metal and rubber. Yet there are cases where protection is the aim in view, nickel being a common metal applied. Often untreated aluminum, when exposed to the atmosphere, will form a smut which is easily detectable by wiping with the hand or cloth. Electroplates for finish are usually chromium, nickel, copper, brass, silver, gold and oxidized modifications of some of these.

Special Reasons for Plating

Silver is applied to electrical equipment to decrease contact resistance or to improve surface conductivity. Brass facilitates vulcanization of rubber in bonding it to metal. Copper and nickel facilitate assembly of component parts by soft soldering, heavy chromium deposits reduce friction and increase wear resistance, also resistance to alkaline environment.

Zinc is used on threaded parts to prevent seizing where ordinary lubricants are not permissible; also, in very special cases, to protect against corrosion. Tin is used to reduce friction. The most common applications of plating are in triplicate: copper, nickel and chromium, in order named.

Aluminum, with its naturally soft silvery color, possesses an attractive appearance, and its many physical characteristics make it a desirable material of manufacture. Why then "gild the lily" by electroplating? The basic reason for this electroplating on aluminum and its alloys is to change its surface appearance, perhaps to match non-aluminum metals in the assembly. Plating changes the appearance or color of the surface. It is often done to create consumer interest and is important in merchandising, part replacement, customer trends and sales appeal.

Besides lending eye appeal, it often increases or provides additional utility value to aluminum. Brass deposits make it possible to bond rubber directly to the plated aluminum part and develop a bond strength in excess of the tearing strength of the rubber around 2000 psi. The bonding of rubber to aluminum through plastics adhesives is also practical.

Again, the soldering of aluminum with special solders and fluxes is common procedure. Work with so-called soft solders is usually not considered satisfactory. However, through the use of a copper, nickel or brass electroplate it is readily handled. If the color of the copper or brass, where not covered by the solder, is not wanted it is easily removed by chemical treatment with little or no effect on the solder.

One experienced plater states that for soft soldering it is best to coat with nickel only, this being a better metal than copper for several reasons. One is that nickel is not readily dissolved by molten solder, hence thinner coatings can be used, particularly if dip soldering is to be done. The nickel plate should be applied from a solution that gives an active nickel, such as the following solution:

Nickel sulfate	16 oz.
Ammonium chloride	4 oz.
Boric acid	3 oz.
Sodium sulfate, anhydrous	16 oz.
Anodes rolled depolarized	—
Cathode current density	5-15 amp. per ft.^{2}
Temperature	70-90 F

It must be realized, however, that nickel is not as easy to solder as copper. Moreover, copper has its friends who will concede no inferiority. Thus they say that though zinc will roll back when one attempts to apply solder to the plated coating, no such trouble is encountered with copper. It resolves itself into personal opinion whether one uses copper, nickel or brass.

Another illustration of advantages of plated aluminum is current-carrying bus bars. The bus bar assembly system requires several joints. Silver plating of aluminum at joints is of definite advantage. With passage of time—and current—more and more aluminum oxide builds up at the joint, retarding passage of current. However, when silver plated, the only deterioration is formation of silver salts, but these salts do not resist passage of electricity. (Ordinarily a joint compound that prevents oxidation of aluminum joints is used, rather than silver.)

For outdoor use where there is exposure to salt atmosphere or high humidity, many believe that cadmium on aluminum gives best performance and longest life, because the cell potential between cadmium and aluminum is low.

One of the interesting uses is that of the Van der Horst Corp., Olean, N. Y., for preparing aluminum cylinders of internal combustion engines for porous chromium plating, the resultant surface having superior wear resistance, partly because of ability to retain a lubricant when used as a bearing surface.

Several of the more rare metals, such as indium, platinum, palladium and rhodium, may be plated on aluminum if desired. After the work is precleaned, it is nickel plated, usually on a copper undercoat, and then the rare metal plated upon the nickel.

Most Satisfactory Aluminum Alloys

Almost all aluminum alloys can be plated satisfactorily, with the exception of those containing more than 2½% magnesium or greater than 10% silicon (though one expert believes he can handle 12 to 13%). A good casting alloy that can be plated successfully contains 9 silicon and 3% copper. Of the wrought alloys, 52S is the most difficult to plate. Those readily plated are 2S, 3S, 17, 24 and 61.

Corrosion Factor

Unfortunately there exists a high electrolytic potential between aluminum and most metals plated on it. Accordingly for outdoor exposure plated aluminum is not ideal. Similar conditions are encountered with copper and nickel plated zinc-base alloy die castings, yet many plated articles of this type are in commercial use. In short, plated aluminum articles are not unique in having a high potential between base metal and coating. As stated before, cadmium probably gives the best performance. Though some advocate a thick coating of plated metal to guard against corrosion, there is always danger of the coating being scratched or nicked to expose the aluminum. According to exposure tests by the research department of International Nickel Co., Inc., for normal exposure conditions, a given thickness of nickel over aluminum will produce a more lasting deposit than an equal thickness of nickel over steel. An electroplating authority conducted extensive tests on various thicknesses of copper and nickel plating on aluminum, and thicknesses as great as 0.002 in. were quickly broken down by salt spray or high humidity. These tests were duplicated in great detail by the American Thermos Bottle Co., Norwich, Conn., who had some serious corrosion problems with nickel plated and copper-nickel plated aluminum. He found, too, that copper as an undercoat for nickel, or copper by itself on aluminum, was not as good as nickel plated aluminum when the plating was done properly. It is understood that others, formerly using copper as undercoating, are attempting to eliminate it under instigation of leading automotive plating authorities.

Be it said that the experience of the American Thermos Bottle Co. was with bright nickel plating solutions. It is suggested that a soft, more ductile nickel would give better results. Others have suggested, too, that so-called "gray nickel" is more effective protection than bright nickel. A skeptic concedes that if a coating of nickel, 0.003 in. thick, is applied and is not abraded, it will stand up satisfactorily against corrosive atmospheres, yet the risks are great.

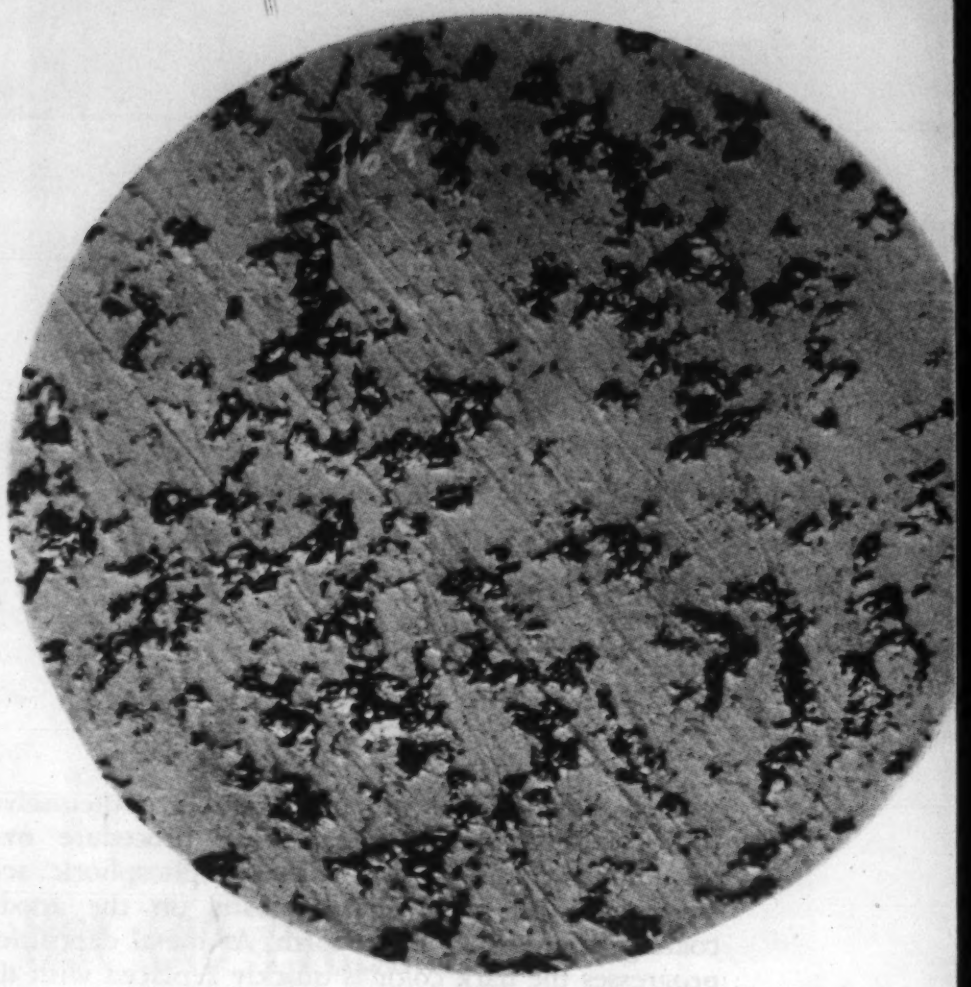
Apparently the cell potential is even more marked if copper is present. As a result the aluminum corrodes rapidly when it is in contact with corrosive conditions such as salt, air, acidic solutions or warm water. This corrosion causes the plate to be undermined and blistering develops. The actual degree of corrosion is much greater than would be experienced with the same thickness of nickel upon steel. Usually the advocates of plated aluminum themselves recommend caution because they do not want to see it get a black eye from misapplication.

Chromium is electrolytically deposited on the walls of aluminum cylinders. The combination provides for wear resistance and heat dissipation. (Photo: Courtesy Van Der Horst Corp. of America)

Applications

Historically, the commercialization of nickel plated aluminum followed investigation by Dr. H. K. Work under a fellowship established by the Aluminum Co. of America at Mellon Institute of Industrial Research in 1925. Among the earlier commercial applications were automobile hub-caps, cafeteria trays and numerous novelty articles. This was the metal replacement process, using nickel chloride in hydrochloric acid. The process failed because of its unreliability and high buffing costs.

One authority on the subject states that he knows personally of 300 applications. The bulk of them have come in recent years, corresponding with the heyday era for aluminum.



Wear resisting chromium, applied to aluminum bearing surfaces by the Porus-Krome process, provides oil reservoirs as shown. Magnification 100X.

Some of the typical applications it is appropriate to mention are: the Keystone Mfg. Co., Boston, uses the Alumon process for plating parts of their movie camera; Bell & Howell, Chicago, uses it for the same purpose. Lipman's Plumbing & Heating Supplies, Brooklyn, uses the process for plating plumbing goods. Troy Sunshade, Troy, Ohio, plated aluminum chairs and chaise lounges with chromium. The Sonotone Co., Elmsford, N. Y., uses it for hearing aids, with rhodium the plating metal. The Ansco Corp., Binghamton, N. Y., have such plated parts in their new reflex camera.

Hardware is being plated on a large scale in barrels, particularly with brass. Among common items so treated are buttons, buckles, jewelry, electrical appliances, radar and radio parts.

Certain aluminum alloys are etched with acids and plated directly with chromium. An old application is the chromium plating of aluminum cylinders used in small gasoline engines, such as outboard motors.

Here are some other applications, with the type of plating, all of which have met with encouraging success: Tubular furniture, with bright chromium plating; wrought and cast hardware parts, bright chromium and brass plating; thermos jug parts, chromium; jewelry (bracelets, earrings, lapel pins, etc.), nickel, chromium, gold and silver plating; small link chains, gold, silver and chromium; wrought and cast bathroom fixtures, bright chromium; novelty items, chromium and oxidized copper and brass; hot air registers, oxidized copper and brass; wrought and cast fittings, zinc (corrosion protection and anti-seizing threads); batons, chromium; automotive hardware parts, chromium.

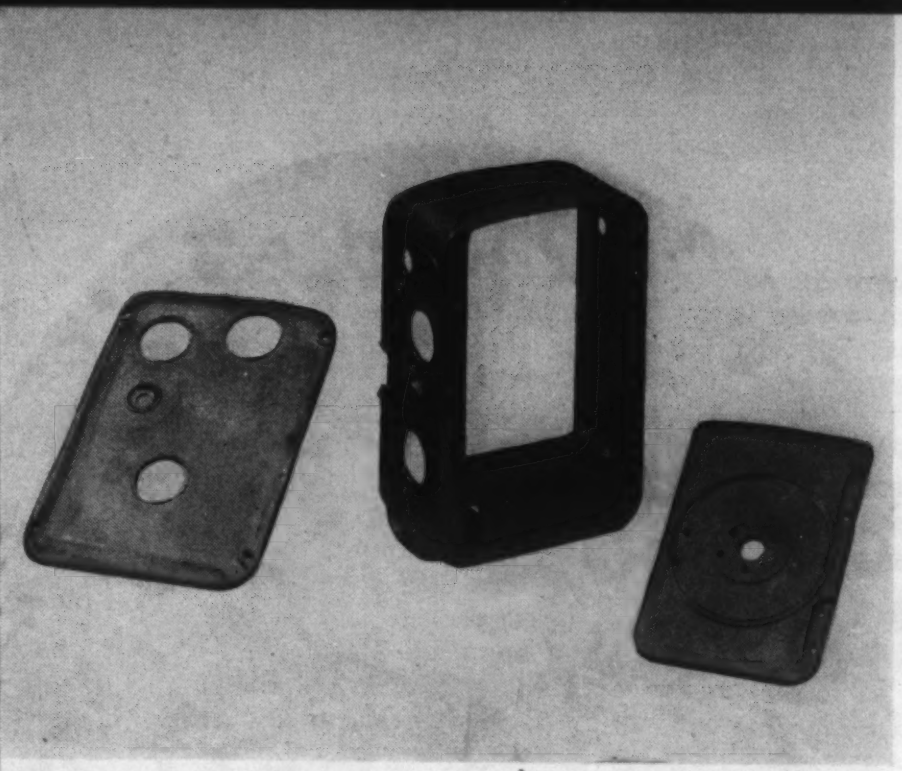
One interesting and recent application is for pressing heads used in machinery for pressing clothing. The cast aluminum head was an improvement over the cast iron head because it did not rust in the constant steam atmosphere, it had better heat conductivity, and was lighter in weight. However, an oxide formed on the surface of the aluminum alloy which absorbed the dye from a colored fabric, then transferred it to a white fabric as soon as that was pressed. This difficulty was overcome by plating the aluminum alloy head directly with chromium.

Highlights of the Process

Authorities are well agreed that the zinc immersion and phosphoric anodic processes are the most practical. Of these two, the former is recognized usually as the most convenient and economical, with most consistent results. It is suitable for large or irregular surfaces. A solution of sodium zincate in caustic soda is used. When aluminum is immersed in this solution an adherent and continuous deposit of zinc is formed. While the zinc immersion procedure is not new, it has not attracted much commercial interest until lately. It most nearly approaches a universal pretreatment for aluminum and its alloys. It is definitely less critical than the anodic coating procedures.

Coatings on 3S alloy are of the order of 0.3 mg. per sq. in. in 2 min. (0.0000026 in.). The bond strength is generally greater than the cohesive strength of the base metal. Apparently the bond is inter-atomic rather than mechanical. Usually a copper strike, from a Rochelle copper solution, is first applied over the zinc before the final plating metals are superimposed. The Alumon process of Enthone, Inc., New Haven, Conn., is a zinc immersion process that employs copper, the sponsor claiming that the presence of copper in the zincate solution, under U. S. Patent 2,142,564, gives more satisfactory results than a plain zincate dip. The zinc process, unlike the phosphoric acid anodic process, does not interpose an electrically resistant layer, hence is suitable for silver coatings for electrical applications.

The phosphoric acid anodic process depends on the fact that certain types of anodic oxide coatings function satisfactorily as a surface for the electroplating of aluminum. The anodic coatings are ex-



The parts of an 8-mm. movie camera shown here are plated aluminum die castings. They were plated by the zinc immersion process and then given a satin chromium finish. (Photo: Courtesy Bell & Howell Co.)

tremely adherent to the metal and are themselves quite porous. During the plating procedure over the anodic coating made with the phosphoric acid electrolyte the metal first deposits on the anodic coating in a dark or black form. As metal deposition progresses the dark color is quickly replaced with the characteristic color of the electrodeposit. The original dark color implies that the coating is finely divided and can be present as fine fibers extending through some of the pores of the oxide coating.

There are some anodic coatings on which the metal can be electroplated directly and others which need further chemical treatment before they function satisfactorily. One such is U. S. Patent 1,971,761 of Krome-Alume, Inc., Lockport, N. Y.

There is danger that highly alkaline solutions will attack the oxide coating before it becomes covered with the electrodeposited metal. An undercoat of copper from pyrophosphate copper solution (U. S. Patent 2,250,556—United Chromium, Inc.) would first be required preparatory to the deposition of brass, or other metallic deposits from highly alkaline solutions. It is especially suitable for plating on aluminum because it is operated at a pH of 8.5, whereas the ordinary cyanide copper bath is pH 12.5, which is 10,000 times more alkaline than the pyrophosphate copper bath.

The Unichrome pyrophosphate copper bath is used after pre-treatment by one of the processes developed by the Aluminum Co. of America, Enthone Co. or Krome-Alume, Inc. After the pre-treatment, the Unichrome process provides for plating with copper, nickel and chromium. Such articles as aluminum coffee percolators combine the lightness and ease of fabrication of the aluminum with the brilliant, nontarnishing chromium plate which has become popular on articles made of steel and brass.

The phosphoric acid anodic process is sensitive to small variations in alloy composition. Likewise, as metal purity increases above that of 2S metal (99.0 to 99.3% aluminum) the metal becomes less susceptible to the anodic preparatory treatment and more difficult to plate. It is not applicable to the usual die casting alloys, and only limited work has been done with sand casting alloys.

Final Impressions

One expert who has worked extensively in this technique concludes that there is a definite field for finishes of plated aluminum. He believes, however, that where the color and appearance of nickel and chromium plated finishes, hardness of chromium, conductivity for electricity and other functional characteristics are not required, the other types of finishes for aluminum, such as the anodic and chemical finishes can be used to better advantage than plating. There are places, of course, where these cheaper finishes will not be accepted. Thus, in jewelry the intrinsic value is to be reckoned with in expensive and medium-priced jewelry. A gold-colored anodic finish will probably not be acceptable. The customer will insist on genuine gold plate.

The bugaboo of corrosion must always be considered. Thus, plated steel appears to perform better than plated aluminum, once the plate has been broken. While red rust stains will appear around the weak spot on the plated steel, the plate does not appear to lift, as with plated aluminum or with plated zinc-base alloys. However, just so long as the electroplate on the aluminum article remains intact, little difference is evident between aluminum and other metals similarly plated. One important consideration is, of course, an economic one. Though it may be possible to put on a thick enough coating of nickel or other protecting metal to guard against severe exposure, can this thick coating be used consistent with competitive sales conditions?

Besides major advantages of plated aluminum, already mentioned, there are minor ones. Thus, the high specific heat of aluminum makes it valuable for sole plates in flat irons. Another advantage is aluminum's high heat conductivity

As to costs, on a comparable basis of plating the cost on aluminium will vary but little from the cost of plating the same job in brass or steel. Of course, it is the cost of the finished product that is of prime importance, assuming performance equalities.

Acknowledgments

Special credit is due the following for their help and data in preparing this article: F. Keller, chief, metallography div., Research Laboratories, Aluminum Co. of America; R. E. Pettit, general manager, Chicago Thrift Co., Chicago 22: Walter R. Meyer, president, Enthone, Inc., New Haven, Conn.; and Walter H. Prine, asst. chemical engineer, International Nickel Co., Inc., New York 5.

Good pressing and die design for proper metal flow assures quality hot die pressings of copper-base alloys.

Designing Copper-Base Alloy Hot Die Pressings

by **F. S. HYDE**, Scovill Manufacturing Co.

SATISFACTORY HOT DIE PRESSINGS of copper-base alloys are, to a great extent, dependent upon proper metal flow. To assure this flow, the design of both the pressing and the dies must be considered carefully and the size of the slug accurately gauged. Naturally, slugs must be sufficiently large to fill the die cavities, yet sufficiently small to avoid excessive flash.

Small tolerances affect metal flow and substantially increase die costs. The greater the tolerances that can be allowed in the finished pressing, the greater the life of the pressing dies. Die surfaces can be dressed more often without exceeding the specified tolerances of the finished pressing. An example of this can be seen in Fig. 1.

If a cavity is to be forged in, the section at the bottom of the cavity should have a liberal thickness and tolerance. This dimension, as shown in Fig. 2, is controlled by the moving die and, therefore, subject to greater variation.

Do not specify thin sections (under 0.1 in.) unnecessarily. See Fig. 3. The metal will not flow readily. Furthermore, the tendency toward rapid cooling will either cause fractures or perhaps necessitate an extra operation.

At all intersections, allow as large radii and fillets as possible. Pressing a sharp-cornered die into a section, similar to that shown at *A* in Fig. 4, will eventually burn off the corner of the die. This necessitates frequent replacement and boosts die costs. Pressing metal into a sharp corner, as shown at *B*, causes the die to crack at the corner because of the excessive pressure required. Metal will follow the shape of the die readily when a generous radius is allowed, as at *C*, and will flow easily into a well-rounded external corner, as shown at *D*.

As a general rule, a 1/16-in. radius in corners and fillets is satisfactory for pressings weighing under 1½ lb. Increased die life and easier die-making is achieved by using radii ⅛ in. or more in size. Conversely, sharper radii increase die-melting costs, reduce die life, and increase the number of rejections caused by improper filling of the die cavities.

Locks, or parting lines in more than one plane, should be avoided wherever possible. These result in higher initial die costs, side thrust in the pressing

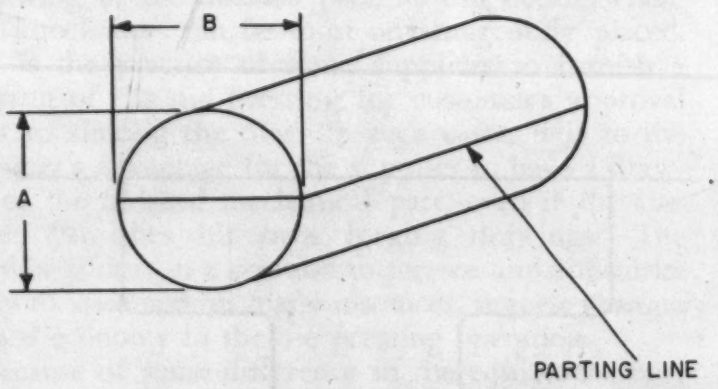


Fig. 1—In this cylindrical body, dimension B can be held closer than dimension A. The trimming dies control B and are not subject to the heat checking and wear of the hot forging dies that control A.

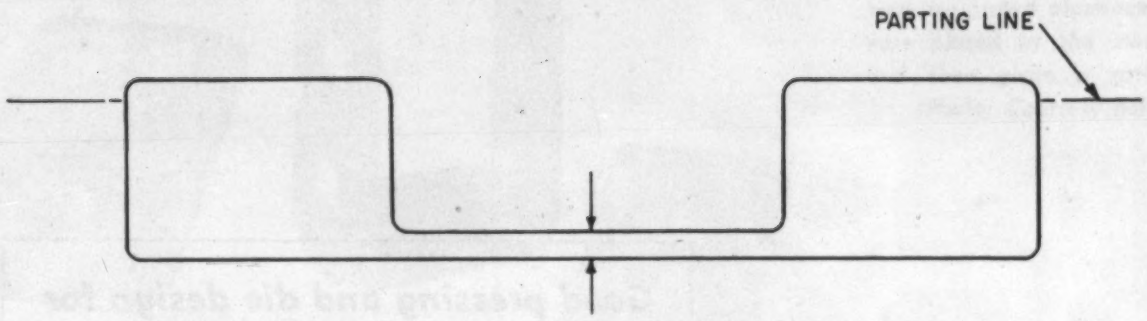


Fig. 2—The section at the bottom of the cavity should have a liberal thickness and tolerance since this dimension is controlled by the moving die and therefore subject to greater variation.

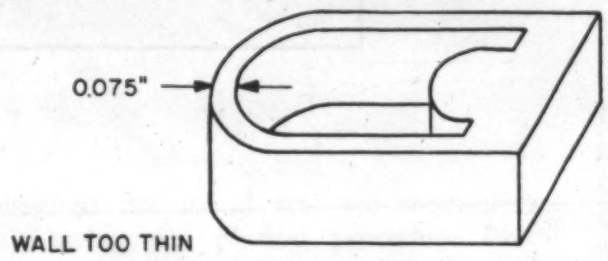


Fig. 3—Thin sections under 0.1 in. should not be specified unnecessarily since the metal will not flow as readily and the tendency to cool will either cause fractures or perhaps necessitate an extra operation.

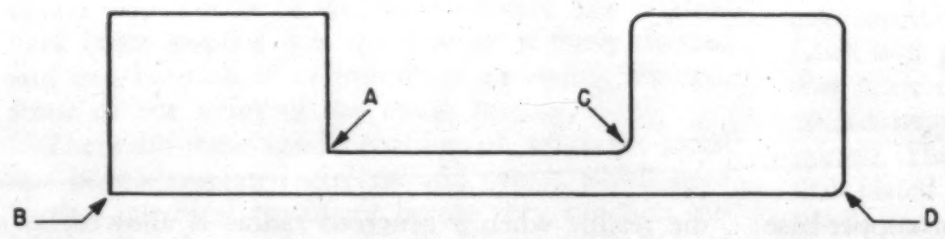


Fig. 4—Large radii and fillets should be used at intersections wherever possible. Sharp corners, as at A and B, will increase die replacement. Rounded corners, as at C and D, facilitate metal flow.

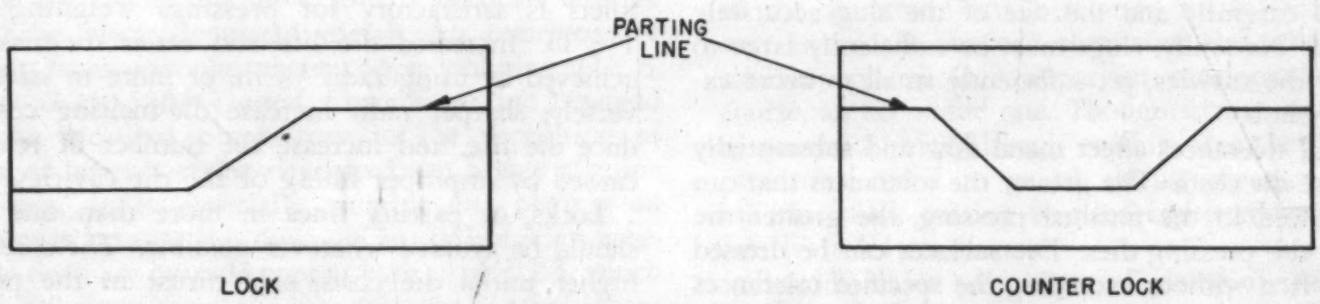


Fig. 5—Locks result in higher initial die costs, side thrust in the pressing operations and greater die wear. If a lock cannot be avoided, a counterlock should be used to balance the pressing and eliminate side thrust.

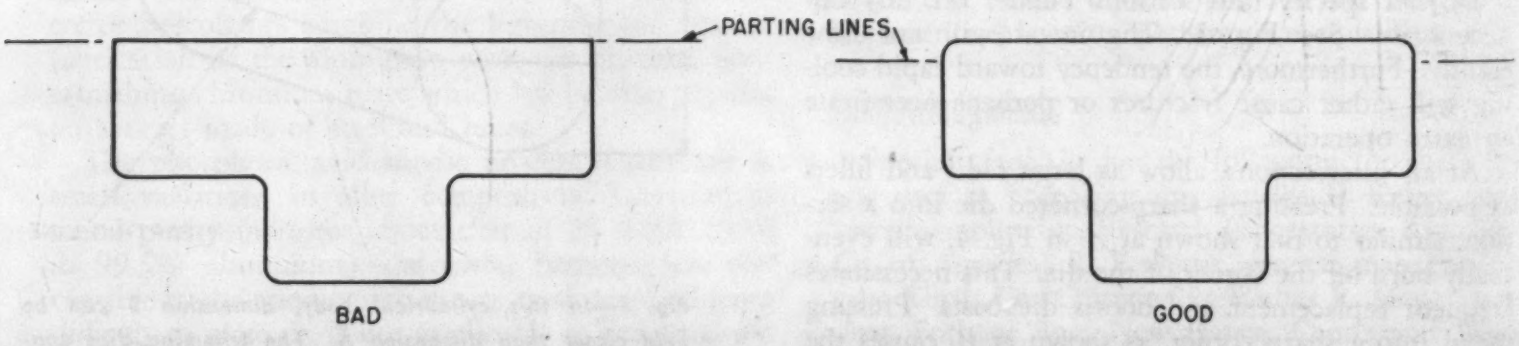


Fig. 6—Parting lines along the upper edge of the pressing will cause the metal to break or tear, thus leaving fins or burrs that sometimes must be removed and that are always a hazard in handling.

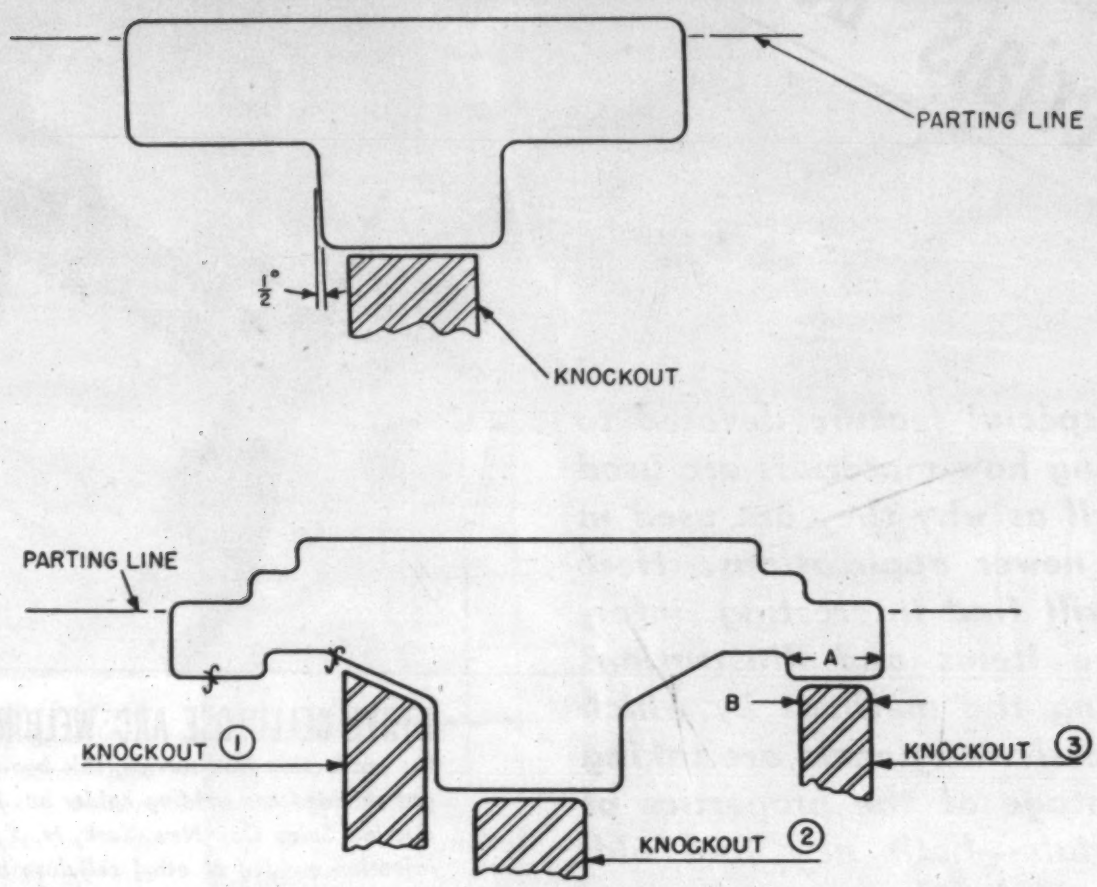


Fig. 7—Vertical extrusions require very little taper if a positive "knockout" is used. Even with ½ deg. of draft, the first upward movement of the forging completely separates the part from the die, thus relieving all friction.

Fig. 8—Positive "knockouts" should be as large as possible and on a horizontal surface sufficiently removed from any vertical extrusion which would weaken the die and shorten die life.

① NOT GOOD - NOT ON HORIZONTAL PLANE AND TOO CLOSE TO VERTICAL SHANK

② GOOD

③ GOOD, BUT "A" SHOULD BE CONSIDERABLY GREATER THAN "B"

operations, and greater die wear. If a lock cannot be avoided, a counter lock, similar to that shown in Fig. 5, is desirable to balance the pressure and eliminate side thrust.

The parting line should not be at the extreme edge of the pressing. See Fig. 6. Since the flash is usually trimmed with the major portion of the pressing below the surface of the trimming die, a parting line along the upper edge will cause the metal to break or tear. It may also leave fins or burrs which must be removed.

Large draft (taper on vertical sections) is not always necessary. In some cases, excessive draft is as detrimental as too little draft. Vertical extrusions require very little taper if a positive "knockout" is used. Even with ½ deg. of draft, the first upward movement of the forging completely separates the part from the die, thus relieving all friction. In general, not over 3 deg. draft is necessary. When pressing drawings are made, special care should be taken to show whether the dimensions include the required draft. See Fig. 7. This saves considerable time and confusion in the shop.

Where positive "knockouts" are used, their location is important, both from an appearance and structural standpoint. They should be placed so that the raised or depressed marks resulting from the "knockout" can be removed in subsequent machining or else located where the marks are unobjectionable in the use of the pressing. Structurally, "knockouts" should always be on a horizontal surface and sufficiently removed from any vertical extrusion which would eventually weaken the die. See Fig. 8.

Care must be taken that weak sections of the pressing are not bent while ejecting the part. This will occur if the "knockout" pins are located too far from a central point at which the pressing might stick. "Knockout" pins should be kept as large as possible and "balanced" on the impression to avoid any tendency of tipping the part in the die. If the design of the dies is left to the pressing supplier, working from a drawing of the finished part, he can decide where the "knockouts" can be most advantageously placed.

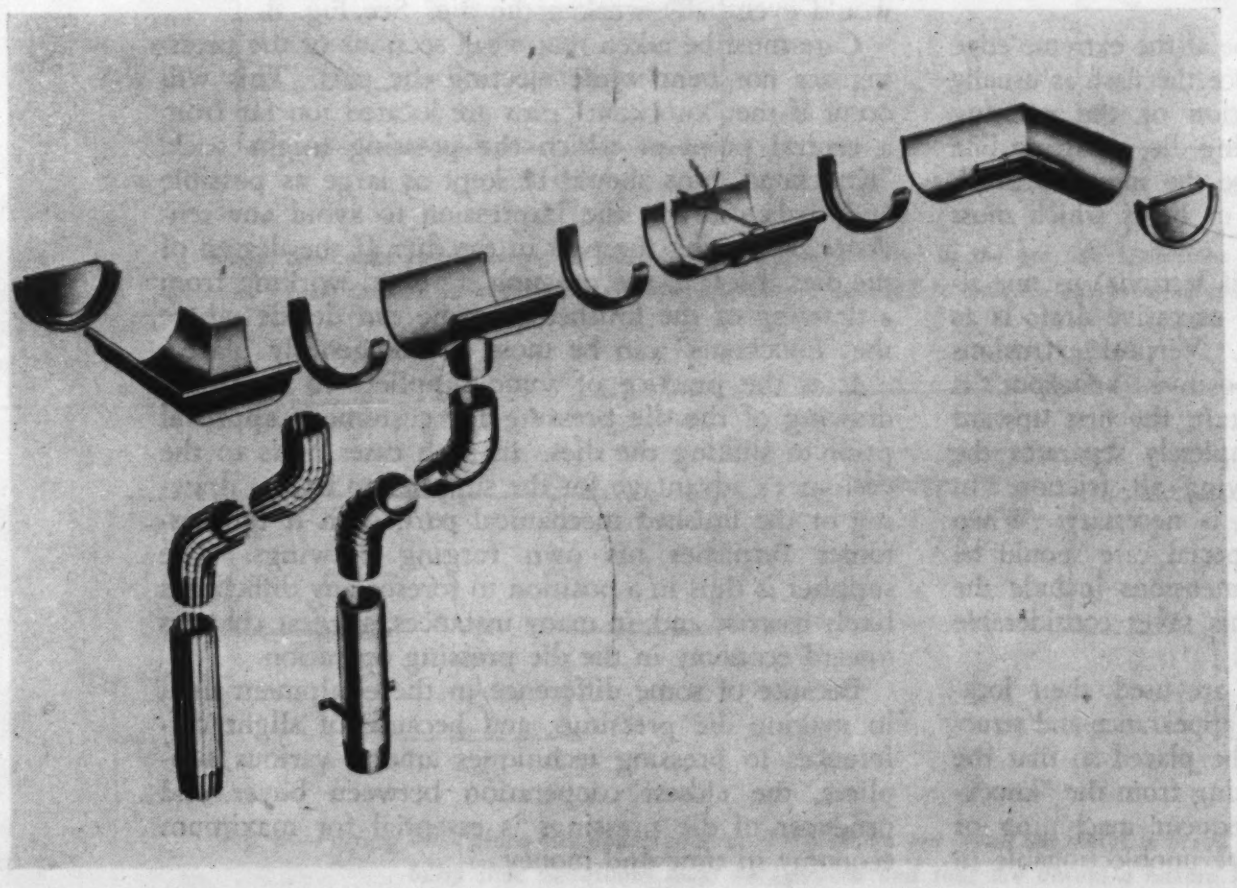
It is the practice of some suppliers to furnish a drawing of the die pressing for customer's approval prior to sinking the dies. In such cases, it is to the customer's advantage for the supplier to have a drawing of the finished mechanical part, even if the customer furnishes his own forging drawings. The supplier is thus in a position to foresee any difficulties likely to arise and, in many instances, suggest changes toward economy in the die pressing operation.

Because of some difference in the equipment used in making die pressings, and because of slight differences in pressing techniques among various suppliers, the closest cooperation between buyer and producer of die pressings is essential for maximum economy in time and money.

Materials at Work

—A special feature devoted to showing how materials are used as well as why they are used in their newer applications. Here you will find interesting, informative items and illustrations showing the methods by which progressive engineers are taking advantage of the properties of materials—both new and old.

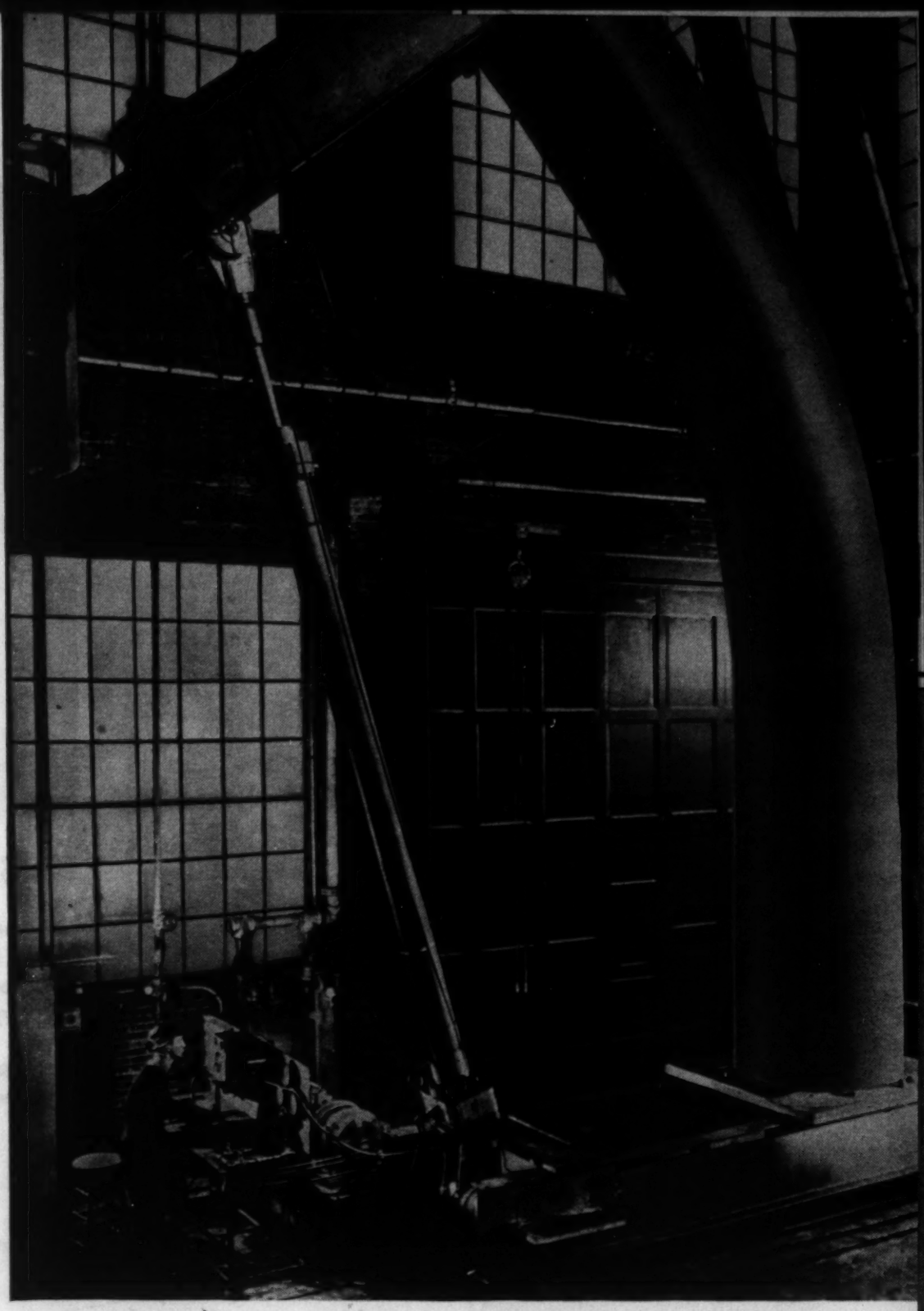
ETHYL CELLULOSE ARC WELDING HOLDER *Designed for production line service, this heavy-duty water-cooled inert-gas-shielded arc welding holder has been developed by Air Reduction Sales Co., New York, N. Y. The all-plastic exterior, injection molded of ethyl cellulose by the Hungerford Plastics Corp., Murray Hill, N. J., insulates against the high frequency current required for arc-starting and arc-stabilization. This light-weight plastic is extremely tough with exceptionally high impact strength and good moisture resistance. The completed holder, with built-in water circulating system, weighs 28 oz.*



ALUMINUM RAIN-CARRYING EQUIPMENT *Only one-third to one-half the weight of conventional materials and costing half as much, these aluminum eaves troughs, conductor pipes and fittings are produced by the Reynolds Metals Co., Louisville, Ky. The metal weathers to a soft, gray-white upon exposure, yet is easily painted if desired. It will not stain adjacent walls and exerts no toxic effect on the water carried. The equipment is installed by the traditional slip-joint method, and soldering is unnecessary. Where the aluminum comes in contact with a dissimilar metal, the latter should be coated with aluminum pigment asphalt paint to guard against the possibility of galvanic action.*

BENDING MACHINE FOR LARGE DIAMETER, MILD CARBON STEEL PIPE

Capable of bending either thin or thick-walled pipes up to 100 in. in dia., this hydraulic machine obviates the welded-segment technique formerly used to obtain pipe curves. The smooth, even bend results in uniform pipe contours, inside and out; effects of eddy currents and fluid erosion in stream flow are thus minimized. Because the pipe is bent hot and slowly cooled, the stress remains uniform throughout the bend. In typical use, heat is applied until the temperature of the pipe reaches 1450 F. At this temperature, the yield point of mild carbon steel is reduced to about 1/10 of the room temperature value. This reduces the external bending force which must be applied. Hydraulic loading completes the bend to a contour accuracy of 0.05 degrees. The equipment was developed by M. W. Kellogg Co., Jersey City, N. J., and is currently being used to produce 50-in. pipe bends for the carrier lines of large oil refining units.

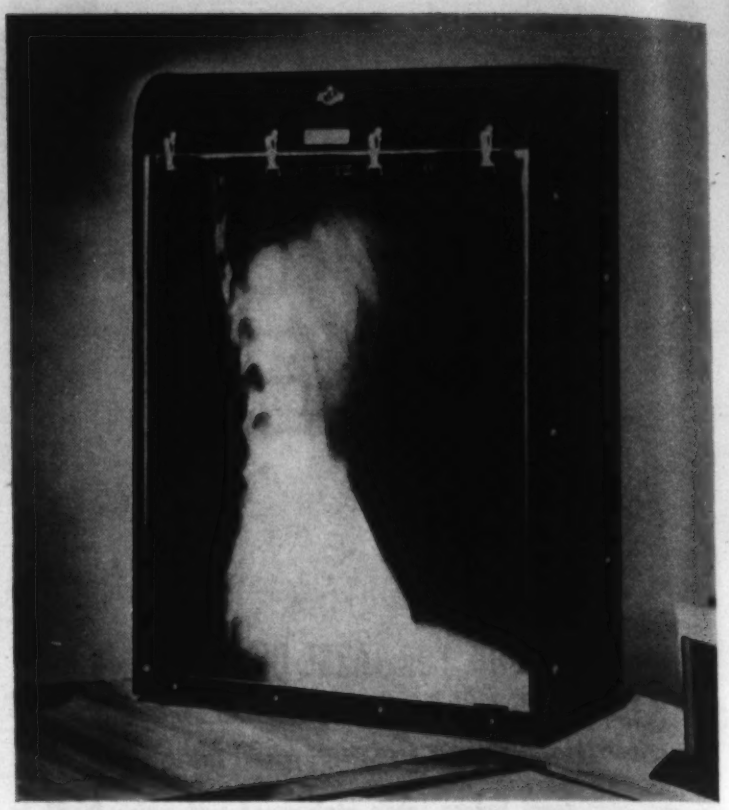


MOLDED NYLON MACHINE PART

To eliminate the need for lubrication at operating speeds of 15,000 rpm., this textile flyer block of du Pont nylon has been developed by the M. J. McHale Co., Scranton, Pa. Flyer blocks guide yarn being unwound from spools, the blocks and guide wires rotating on spindles above the spools. Blocks formerly used required lubrication on the spindle, and at high operating speeds tended to throw oil on the yarn. Nylon, requiring no lubricant when used as a bearing material under light loads and high speeds, eliminates this cause of yarn spoilage. The injection-molded nylon block comes from the mold with a smooth hole to fit the spindle; will not bend out of shape or bind; and requires no finishing operation. The looped guide wires, sprung into grooves molded in the block, can be replaced readily when worn. Because of the molded construction, all blocks of a single type are uniform in size and weight. As an added advantage, this nylon part weighs less than any other flyer block of comparable size.

VINYLIDENE CHLORIDE TUBING AND FITTINGS

A gooseneck used in the manufacture of rayon was formerly made of glass, with lead fittings. To solve breakage problems, a new part was developed by the Parker Appliance Co., Cleveland, Ohio, from Saran tubing and molded Saran fittings. Dovetail thread forms were used to overcome cold flow in the material. The plastic, a product of Dow Chemical Co., Midland, Mich., not only has the strength and resistance to corrosion necessary for this application, but gives a longer service life to the part than the materials formerly used.



TRANSLUCENT ACRYLIC DIFFUSION PANEL

To provide the evenly diffused light necessary for accurate interpretation of radiographs of castings and weldments, the General Electric X-Ray Corp., Milwaukee, Wis., has adopted panels of translucent Plexiglas for its radiograph illuminators. This acrylic plastic, a product of Rohm & Haas Co., Philadelphia, Pa., is used in ½-in. sheets measuring 14 by 17 in. It replaces the flashed opal glass formerly used because of its superior diffusing quality, uniform density, freedom from flaws, and its high shatter-resistance.

DIE CAST MAGNESIUM FURNITURE

Weighing nearly 2 lb. less than a comparable wood frame and nearly 3 lb. less than a similar aluminum design, these magnesium folding chairs have been developed by the Louis Rastetter & Sons Co. The chairs, developed with the cooperation of the Dow Chemical Co., have frames which are die cast as units with no welded joints or seams. The magnesium frames are finished in natural metallic or wood-finish shades, and incorporate a patented hinge and brace that enables the chairs to fold flat for storage. Sponge rubber cushions and plastic upholstery are utilized.

ATERIALS & METHODS MANUAL

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

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Free Cutting Steels

by T. C. Du Mond, Managing Editor,
Materials & Methods

When speed of output is the first essential on parts requiring considerable machining, the free cutting steels should be investigated. This group of carbon steels offers a wide range of engineering and machining characteristics which make possible their use on a variety of parts. When used on automatic screw machines and similar equipment, their free machining qualities permit the utmost in manufacturing economy.

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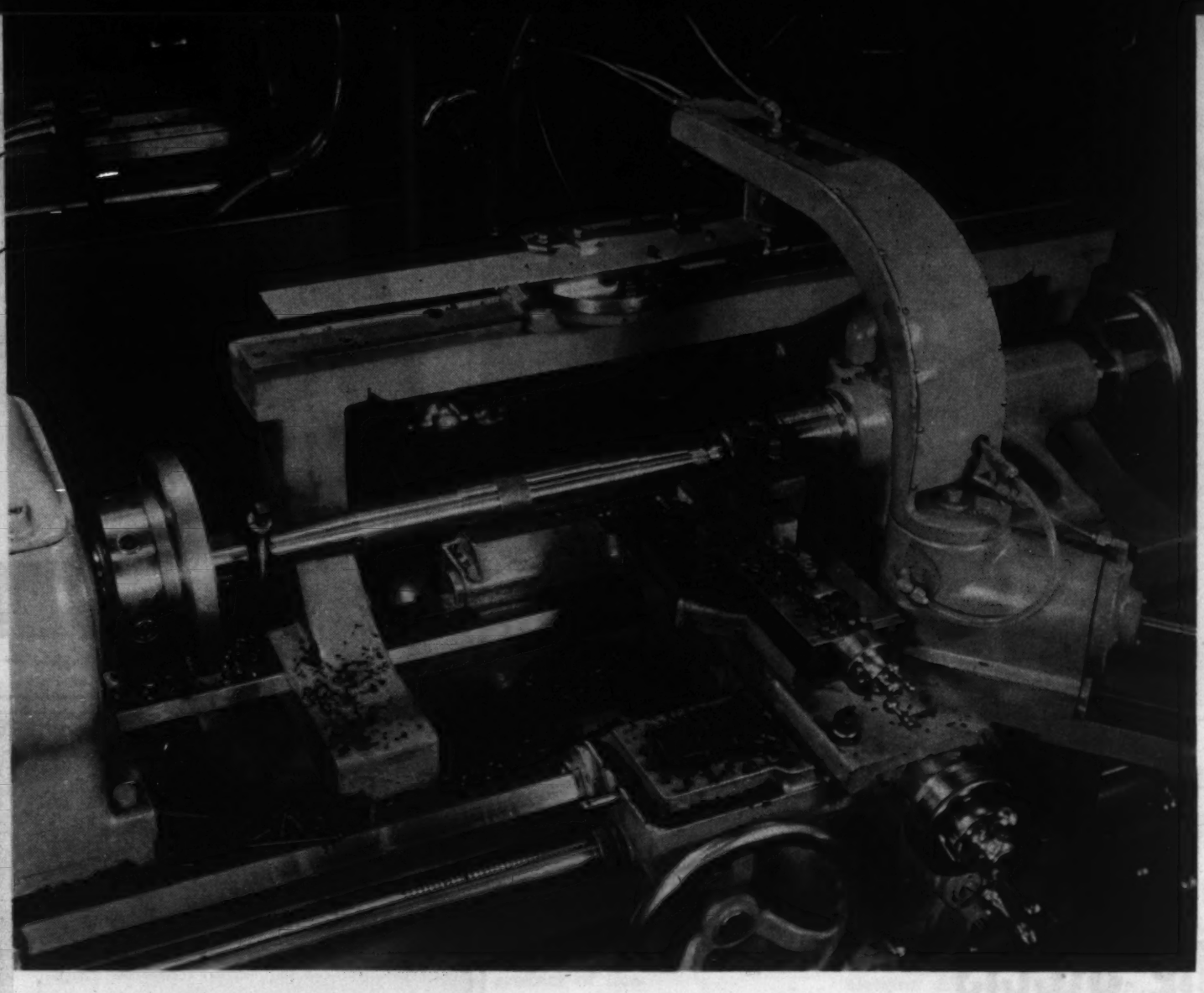


Free cutting steels are well suited to long shafts and pieces on which several diameters are required. This piece is being turned on a Monarch lathe with air tracer control.

Introduction

Of all the characteristics of metals, machinability is probably the one most difficult to define. Likewise, machinability is dependent upon so many variables that any reference to machinability should be complete with a full bill of particulars.

Among the factors which influence the removal of surplus metal through cutting are: the material, the type and condition of machine tool, shape and material of the cutting tool, cutting fluid or coolant used, and speeds and feeds employed. Another factor, often overlooked, is the skill of the machine operator.

One of the simplest definitions of machinability states that machinability is that property of a material which permits its ready removal by a cutting tool at economic speeds, producing a satisfactory finish and providing normally expected tool life. One of the most common methods of measuring relative machinability of materials is by determining, under fixed conditions of speed and depth of cut, which of the materials allows the longest tool life between grinds.

Although machinability is important in connection with the use of any type of machine tool, this characteristic is most important when materials are being selected for the making of parts by means of automatic screw machines. The chief reason for being of automatic screw machines lies in the fact that these complex pieces of equipment can turn out almost unbelievable quantities of finished parts in a given period.

Thus, if steels were not available to take advantage of the potentialities of automatic screw machines, mass production as we know it today would be somewhere in the future.

Not the least of the properties which make a "free cutting" steel free cutting is the character of the steel which results in small chips forming during machining. Long, stringy chips would foul the high-speed, complex screw machines with their fast positioning turrets, tools and spindles.

Thus, at the insistent prodding of mass production we have seen a steady development of special steels during the last 60 to 70 years. Today we have a special group of steels recognized by the American Iron & Steel Institute, the Society of Automotive Engineers and industry as "free cutting" steels. While the term "free machining" is often used synonymously with "free cutting," there is a difference. There are several steels which, by all standards, are free machining but which are either more highly alloyed or which are designed for other uses than those which are labelled free cutting.

Free cutting steels differ from ordinary carbon steels, chemically at least, in that with ordinary carbon steels sulfur remains because it is too difficult or expensive to be entirely removed. In contrast, sulfur is deliber-

ly added to free cutting steels to help ir machinability. Consequently, free tting steels are generally classed as ulfurized steels.

In addition, most free cutting steels e finished at the mill by cold draw- g. The cold drawing process adds to e physical properties of the steel as ell as providing the most desirable rface attainable, short of grinding. Both the sulfur additions and the ld drawing are important in attain- g the high machinability of free cut- ng steels.

dentification of Free Cutting Steels

The free cutting steels are easily dentified by reference to the number- ng systems employed by both the merican Iron & Steel Institute and he Society of Automotive Industries. All steels in this group are in the 1100 eries of both specifying groups. The 1 in the four-digit numbers identify he steels as being either basic open earth or acid Bessemer carbon steels, sulfurized but not phosphorized. Whether steel is produced by the open hearth or Bessemer process is shown by a prefix letter. "C" denotes a basic open hearth steel; "B" an acid Bessemer carbon steel. The final two digits indicate the average or maximum carbon content. Thus, B1113 indicates that the steel so labelled is a free cutting carbon steel produced by the acid Bessemer process and having 0.13 max. carbon.

The free cutting steels encompass a group of 27 steels of varying chemical composition having a range of physical properties. As an example, B1112 has tensile strength of from 80,000 to 100,000 psi.; Brinell hardness of 170 to 202. Steel C1137 offers 100,000 to 120,000 psi. tensile strength and 187 to 235 Brinell hardness.

Since it is one of the oldest of the free cutting steels, cold drawn B1112 is the standard by which the machinability of all other metals is rated. Therefore, when a steel, or other metal, has a machinability rating of 70, the meaning is that it machines 70% as well as cold drawn B1112.

Free cutting grades of steel, because of their chemical nature, mill finishing process and intended uses, are furnished only as bar stock including rounds, squares and hex shapes.

Some of the free cutting steels are heat treatable, others can be carburized to make them more wear resistant, while others are not to be subjected to any type of thermal treatment.

There are several steel producers which specialize in free cutting steels, or at least in cold drawn steels of which the free cutting group is an important segment. Probably no company makes all grades of free cutting steels. Most make a range of from 4 to 10 of the steels which are in greatest demand and which offer the widest range of mechanical properties. In addition, many of the specializing producers have their own brands of free cutting steels. These special steels often are standard compositions with possible chemical additions or treatments which vary from normal procedures.

Why These Steels Are Free Cutting

A complete, detailed account of why free cutting steels are so readily machinable would require a volume in itself. However, it seems reasonable to assume that those persons interested in free machining steels should have some interest in why they are that way.

The free cutting qualities are attained by a combination of chemical composition and final mill working. Each has an important bearing on the final properties.

Free cutting steels can be traced back to the point where the Bessemer method of making steel was started. Steels produced by the Bessemer process were found to be far superior in machinability to any other ferrous metals. Even when better steel making methods were developed, it was found that the Bessemer steels retained an edge in machinability.

After numerous experiments, researchers learned that sulfur, generally considered an impurity in steel, made the difference.

Composition

A study of the table of compositions of free cutting steels and a comparison of them with ordinary carbon steels will reveal that free cutting steels constrain considerably more manganese and sulfur than corresponding grades of plain carbon steel for bars. The additional manganese is supplied to combine with the sulfur and form sulfides. The sulfides result in the hardness and brittleness essential to good machinability.

In carbon steels, sulfur combines with iron to form ferrous sulfide (FeS) and with manganese to form manganese sulfide (MnS). These sulfides become films and particles at grain boundaries. Ferrous sulfide inclusions soften and sometimes melt at rolling and forming temperatures, causing cracking or disintegration during forming at elevated temperatures.

On the other hand, manganese and sulfur have a strong affinity for each other and their sulfide predominates. Manganese sulfide inclusions are more refractory than ferrous sulfides and are not as likely to segregate at grain boundaries. Likewise, the manganese sulfide particles are sufficiently plastic to deform with the metal during forming or rolling. Manganese is specified in free cutting steels in ratios ranging from 3 parts of manganese to 1 of sulfur up to 8 to 1. The higher the ratio, the better the hot working properties of the steel.

Manganese, in addition to combining with sulfur to form sulfides, helps to attain a pearlitic structure in steel, making it more suitable for general manufacturing and engineering uses. The addition of manganese in larger amounts has an effect on the heat treating properties of steel. Manganese reduces the critical cooling rate of the steel, making the action of quenching media more drastic than usual.

In many steels sulfur remains as an impurity. In free cutting steels sulfur is intentionally added. Sulfur has much to do with providing the free cutting qualities in steels so classed. Sulfides tend to harden and embrittle the steel. The hardness provided in this manner results in less force being required to rupture chips from the main body of steel. Brittleness causes chips to break up into smaller pieces. Long, curling chips, while fascinating to see, would hopelessly handicap automatic screw machine operations.

Cold Drawing

It can be seen that the chemical composition of a steel is important in

achieving free cutting properties. However, these properties can be profoundly affected by the way in which the steel is worked into its finished mill shape.

Having adjusted the chemistry of the steel to provide all desirable physical properties, plus high machinability, it then becomes the task of the steelmaker to so work the steel as to attain the ultimate in machining properties.

It has been found that cold working generally and cold drawing in particular in bringing the steel down to proper size and shape has a highly beneficial effect.

Cold working is of value in finishing any steel, but its merit is probably greatest when employed on low carbon steels.

Free cutting steels have good machinability in the hot rolled condition. However, cold drawing improves the cutting quality by increasing hardness and lowering ductility.

Cold drawing is a process whereby hot rolled bars are forced or pulled through dies smaller in diameter than the bars being processed. The die tapers from its larger opening down to the desired finished size. Such working, as with all cold working, forces the particles forming the steel into more intimate contact. At the same time grains of constituents are elongated parallel to the direction of drawing.

Cold drawing also improves the physical properties of the steel. On one test it was found that on a low carbon steel cold drawing raised the yield point 102%; ultimate strength, 36%; and, hardness, 36%, over the same steel in hot rolled condition. At the same time ductility was considerably reduced.

Investigation has shown that higher hardness and reduced ductility are important to machinability. Both of these changes have the effect of making the steel more brittle.

Since free cutting steels are most important to automatic screw machine operation, other results of cold drawing are likewise of definite value. Among these plus values are scale-free surfaces, close accuracy of size throughout the piece, and straightness. All of these characteristics are important in screw machine work.

Grades of Free Cutting Steel

While there are nearly 30 specifications for free cutting steels, it is highly improbable that all of them will ever be in production or use at the same time.

Therefore, it will serve our purpose to describe the most commonly used grades. Practically all producers of free cutting steels supply these grades and recommend them for the majority of uses.

Bessemer Steels

B1111—This steel is widely known as Bessemer screw stock. It has good machining qualities but is inclined to be cold short. Because of its cold shortness (tendency to be brittle at room temperatures) B1111 is not recommended for vital parts or those subjected to severe shock. The cold shortness precludes severe cold forming operations such as bending and cold heading. As compared to B1112, B1111 has a machinability rating of 95%. Its Brinell hardness ranges from 172 to 229. Although parts made of B1111 can be carburized and cyanided, open hearth steels of similar grade respond to thermal treatment better. B1111 is used for studs, screws and other automatic screw machine products. Because of the relatively low sulfur content, B1111 can be welded.

B1112—The standard of all machinability ratings is B1112, with a rating of 100%. It is very close to B1111 in many respects, including physical and mechanical properties and uses. B1112 is somewhat less ductile than B1111. Average properties are: tensile strength, 80,000 to 100,000 psi.; yield point, 70,000 to 80,000 psi.; elongation, 10 to 20% in 2 in.; reduction in area, 40 to 50%; and Brinell hardness, 170 to 202.

B1113—B1113 has the highest sulfur content of the Bessemer steels. Likewise, it has the highest machinability rating of all ferrous materials (135%), with the exception of some malleable irons. It is used where production speed and excellent finish are highly

Free Cutting Open Hearth Steels

1947 AISI Number	Chemical Composition, %				1948 SAE Number
	Carbon	Manganese	Phosphorus	Sulfur	
C1106	0.08 max.	0.30/0.60	0.045 max.	0.08/0.13	.....
C1108	0.08/0.13	0.50/0.80	0.045 max.	0.07/0.12	.....
C1109	0.08/0.13	0.60/0.90	0.045 max.	0.08/0.13	1109
C1110	0.08/0.13	0.30/0.60	0.045 max.	0.08/0.13	.....
C1111	0.08/0.13	0.60/0.90	0.045 max.	0.16/0.23	.....
C1113	0.10/0.16	1.00/1.30	0.045 max.	0.24/0.33	.....
C1114	0.10/0.16	1.00/1.30	0.045 max.	0.08/0.13	1114
C1115	0.13/0.18	0.60/0.90	0.045 max.	0.08/0.13	1115
C1116	0.14/0.20	1.10/1.40	0.045 max.	0.16/0.23	1116
C1117	0.14/0.20	1.00/1.30	0.045 max.	0.08/0.13	1117
C1118	0.14/0.20	1.30/1.60	0.045 max.	0.08/0.13	1118
C1119	0.14/0.20	1.00/1.30	0.045 max.	0.24/0.33	1119
C1120	0.18/0.23	0.70/1.00	0.045 max.	0.08/0.13	1120
C1125	0.22/0.28	0.60/0.90	0.045 max.	0.08/0.13	.....
C1126	0.23/0.29	0.70/1.00	0.045 max.	0.08/0.13	1126
.....	0.27/0.34	1.35/1.65	0.045 max.	0.08/0.13	1132
C1137	0.32/0.39	1.35/1.65	0.045 max.	0.08/0.13	1137
C1138	0.34/0.40	0.70/1.00	0.045 max.	0.08/0.13	1138
C1140	0.37/0.44	0.70/1.00	0.045 max.	0.08/0.13	1140
C1141	0.37/0.45	1.35/1.65	0.045 max.	0.08/0.13	1141
C1144	0.40/0.48	1.35/1.65	0.045 max.	0.24/0.33	1144
C1145	0.42/0.49	0.70/1.00	0.045 max.	0.04/0.07	1145
C1146	0.42/0.49	0.70/1.00	0.045 max.	0.08/0.13	1146
C1151	0.48/0.55	0.70/1.00	0.045 max.	0.08/0.13	1151
Free Cutting Bessemer Steels					
B1111	0.13 max.	0.60/0.90	0.07/0.12	0.08/0.15	1111
B1112	0.13 max.	0.70/1.00	0.07/0.12	0.16/0.23	1112
B1113	0.13 max.	0.70/1.00	0.07/0.12	0.24/0.33	1113

mportant. Only the highest speed pacity machines can take advantage f this steel's machinability. B1113 is ot recommended for use in making ital parts, and heat treating is not uggested. Its mechanical properties re similar to those of B1112.

pen Hearth Steels

C1115—C1115 is known as open earth screw stock. It is less machinble than the Bessemer screw stocks, ut has a better combination of trength and toughness. The machinbility rating is 85%. Having better hock and fatigue properties than the receding steels, C1115 can be used n somewhat more vital parts and parts nvolving simple bending, swaging, iveting and forming. General heat reatment is not recommended, but it an be carburized. Average physical roperties are: tensile strength, 70,000 o 80,000 psi.; yield point, 60,000 to 0,000 psi.; elongation, 15 to 25% in 2 in.; reduction of area, 45 to 55%, nd Brinell hardness of 140 to 170. A ypical use is for such parts as piston ins.

C1117—C1117 finds considerable se for parts which are to be case ardened but which must have good achining properties. This steel has nusual ductility for a free cutting teel and responds well to carburizing. Parts case hardened in activated baths an be given refining heats. Its machinability rating is 85%. Average physical properties: tensile strength, 75,000 to 85,000 psi.; yield strength, 60,000 to 75,000 psi.; elongation, 15 to 25% in 2 in.; reduction of area, 45 to 55%; and Brinell hardness, 147 to 170. Some recommended uses are as distributor cams and shafts and universal joints.

C1118—This steel is very close in both composition and properties to C1117. Its machinability rating is 80%, slightly lower than C1117. C1118 is used for solid parts and parts having heavier walls than C1117. The latter steel is preferred when drastic quenching of light sections is involved.

SAE1132—SAE1132 is a special grade which is not included in the AISI free cutting steels. This material is known as a free cutting manganese steel. It is intended for use where SAE1035 and 1040 steels could be used, but better machining, deeper hardening and higher physicals are desired.

C1137—This free cutting manganese steel is often used in place of SAE1045 and 1050 steels because of its better characteristics. It is primarily an oil hardening steel, so extreme care is necessary when water quenching is employed. Although the steel in its cold drawn condition has excellent mechanical and physical properties, it responds to heat treatments to provide a wide range of properties. Its machinability rating is 70%, which places it just on the borderline of the free cutting steels. C1137 is used for generator shafts, washer worm gears, wheel puller bolts and similar parts which must be both hard for wear resistance and tough. Average properties of this steel in cold drawn condition are: tensile strength, 100,000 to 120,000 psi.; yield point, 85,000 to 100,000 psi.; elongation, 10 to 15% in 2 in.; reduction of area, 30 to 45%; and Brinell hardness, 187 to 235.

C1141—C1141 is very close in all respects to C1137. The major difference is that C1141 has a higher carbon content than its sister steel.

C1145—This steel is a high sulfur variant of SAE1045, and is used for similar types of applications. It is chosen because it has better machining qualities. Its uses include adapters, crankshafts, yokes and universal joints.

Sulfur added to free cutting steels to make them machinable also results in smaller chips, important to the operation of automatic equipment.

The straightness and surface qualities of the cold drawn free cutting steels make them well suited for use in automatic screw machines.

While most screw machine parts are small, like these, larger pieces are just as freely turned out when free cutting steels are used. The parts have all been subjected to cold heading operations to obtain the final shapes.

Cutting, Joining, Heat Treating

As the name indicates, and as the preceding information has emphasized, the free cutting steels are readily machinable. Therefore, these steels present no problem in cutting on any of the commonly used machine tools.

Most of the free cutting steels can be given some type of heat treatment, although only the more simple processes are suggested for those in the lower manganese ranges.

Welding is not satisfactory for these steels as a group. Only those free cutting steels with an extremely low sulfur content can be welded. Even with the low sulfur free cutting steels, welding results are not too satisfactory.

Machining

Since it is highly unlikely that any two shops will employ the same set of circumstances in machining, it is impossible to establish definite machining rules and procedures. However, most satisfactory results are obtained with automatic machines which provide high speeds. Likewise, high-speed steel tools are most satisfactory for the large majority of jobs.

One of the best methods of determining the speeds and feeds to employ in machining free cutting steels is based on the surface cutting speed ratings of the various steels. The ratings of each of the free cutting steels is given in an accompanying table.

Speeds and feeds vary with the type of operation and the shape of tool employed. For instance, threading is a much more severe operation than cutting-off. Therefore, speeds will be considerably lower for threading than for a cut-off operation.

Specific suggested speeds and feeds for various tools follow. These are not absolute, and should be used only as reference points from which to determine exact speeds and feeds on any specific job.

Box Tools—Box tools are the most commonly used tools on automatic screw machines. While they can be used for both roughing and finishing, their principal use in today's practice is for finishing. One tool alone can be used in the holder for turning one diameter, or, by using several tools, a number of diameters can be turned at the same time.

With box tools a speed of from 90 to 100% of the rated SFM is generally satisfactory. At these speeds, feeds of from 0.005 to 0.008 in. give best results. The variance in depth of cut is in proportion to the width of tool.

Chasers—As listed, threading is one of the most severe of machining operations. Therefore, speeds of from 30 to 35% of rated SFM are found to be best. With fine threads these speeds may be increased.

Cut-Off Tools—Cutting-off together with sawing is a rather simple operation. With free cutting steels in automatic screw machines, this operation can be carried out at 100 to 110% of rated SFM of the material being cut. At these speeds, feeds of 0.002 to 0.003 in., depending upon the tool width, can be used with good results.

Form Tools—Two different types of form tools are used in screw machine

ork—circular and dovetail. Both are ed to produce a shape in the piece in e big cut, rather than employing veral smaller cuts. Form tools usually ke rather shallow cuts, because of e comparatively wide swath cut. eeds of 100% of rated SFM of the el can be used, with feeds ranging om 0.001 to 0.003 in., depending on over-all width of the tool.

Knurl Tools—Knurling is common- performed with the tools either on e turret or cross slide. While the eeds are the same—100% of rated FM—the feeds vary. Feeds of 0.015 0.030 in. are used when the tools e on the turret and from 0.002 to 006 in. when on the cross slide.

Drilling—Speeds for drilling with wist drills vary with the diameter and epth of the hole, feeds and speeds oth rising with increase in hole diam- ter. Very deep holes may require reatly reduced speeds. Normal speeds ange between 55 and 70% of rated FM for the material. In the size range etween 1/8- and 1/2-in. dia. holes, eeds of 0.003 to 0.007 are satisfactory.

The speeds and feeds indicated are ot the greatest that can be used, by ny means. They have been established or high-speed steel tools which are xpected to maintain, at these speeds nd feeds, a life between grinds of bout 8 hr. and a good surface finish.

Machinability Ratings of Free Cutting Steels

A.I.S.I. Number	SAE Number	Surface Ft. per Min.	% Relative Speed Based on B1112 as 100%
B1111	1111	155	94
B1112	1112	165	100
B1113	1113	225	136
C1108	—	135	81
C1109	—	135	81
C1111	—	150	91
C1113	—	165	100
C1114	—	135	81
C1115	1115	135	81
C1116	—	155	94
C1117	1117	150	91
C1118	1118	150	91
C1119	1119	165	100
C1120	—	135	81
C1125	1125	135	81
C1126	1126	135	81
C1137	1137	120	72
C1138	1138	125	76
C1140	1140	120	72
C1141	1141	115	70
C1144	—	125	76
C1145	1145	110	66
C1146	1146	115	70
C1151	1151	115	70

Cutting Fluids for Machining

Severity of Operation	Type of Operation	Recommended Cutting Fluids
1 (Greatest)	Broaching, internal	Em., Sul.
2	Broaching, external	Em., Sul.
3	Tapping, plain	Sul.
3	Threading, plain	Sul.
4	Gear shaving	Sul., L.
4	Reaming	Ml., Sul.
4	Gear cutting	Sul., Ml., Em.
5	Drilling, deep	*Em.*, Ml.
6	Milling, plain	*Em.*, Ml., Sul.
6	Milling, mult. cutter	Ml.
7	Boring, multiple head	*Sul.*, Em.
7	Mult. spindle automatic screw machines and torret lathes	Sul., Em., Ml.
8	High-speed, light feed automatic screw machines	Sul., Em., Ml.
9	Drilling	Em.
9	Planing, shaping	*Em.*, Sul., Ml.
9	Turning, single point form tools	Em., Sul., Ml.
10	Sawing	Sul., Ml., Em.
10 (Least)	Grinding, plain	Em.
	form	Sul.

Em.—Soluble or emulsifiable oils and compounds
L. —Lard oil
Sul.—Sulfurized oils
Ml.—Mineral-lard oils
Italicized fluids are preferred where indicated

Adapted from recommendations prepared by the Independent Research Committee on Cutting Fluids

Welding

Free machining grades of steels are generally unsuited to welding by any of the currently used welding methods. Steels with less than 0.05% sulfur and in which there is no sulfur segregation can be welded by methods normally employed with carbon steels.

Since the presence of 0.07% sulfur marks the beginning of the free cutting range of sulfur in steels, the steels are not considered weldable.

Excessive sulfur in the steels tends to cause porosity and cracking in the weld metal when arc welding processes are used. Likewise, resistance welds are brittle and unsatisfactory.

Where welding must be done, the only free cutting grade of steel which offers possibilities of fair welding is B1111. Even here the sulfur content is higher than that considered proper for good welds.

Heat Treating

Several of the free cutting steels, particularly those in the higher manganese ranges, can be heat treated to bring out specific properties. All can be subjected to certain thermal treatments, although the Bessemer stocks and other low carbon free cutting steels are only given simple treatments, if any.

Here are the treatments and their recommended procedures:

Annealing—Annealing is done to overcome the effects of cold work. In many cases it provides better forming properties subsequent to the machining operations.

To anneal, heat the steel to between 1150 and 1250 F and cool in the furnace. This procedure is not to be confused with normalizing.

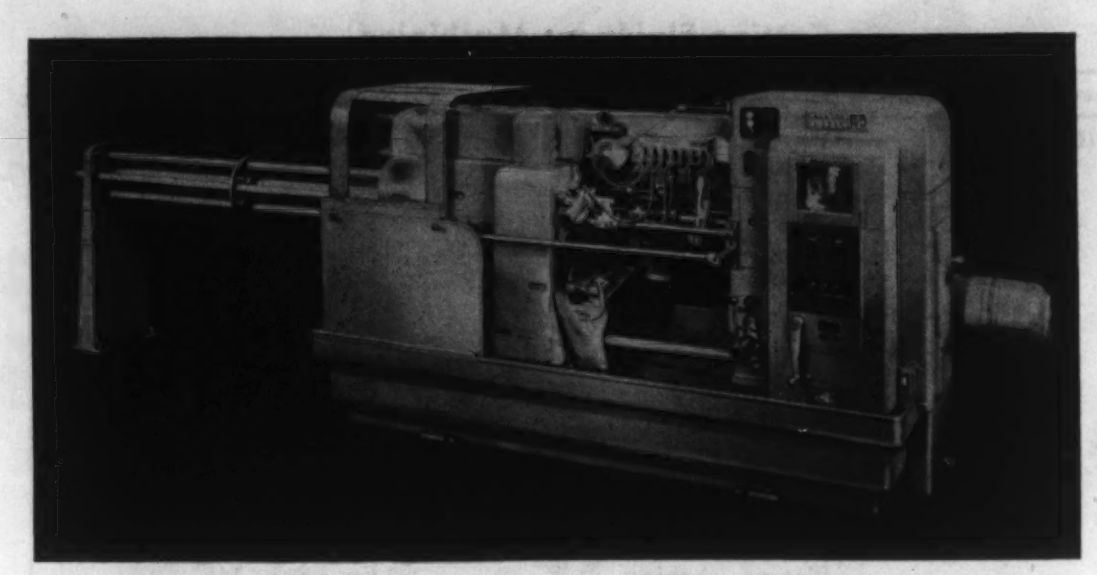
Cyaniding—Cyaniding is an inexpensive treatment intended to produce high surface hardness and provide greater resistance to wear.

In cyaniding, the steel is heated to between 1500 and 1650 F in a sodium cyanide bath. After reaching bath temperature, the parts are soaked for 15 to 45 min. (The thicker the part, the longer the soak.) After soaking, the parts are quenched in lime water. Lime water is recommended to neutralize the cyanide salts.

Carburizing—There are two carburizing treatments. The first is intended to develop a hard surface only. The second results in a hard surface and a tough core.

The first procedure follows: The parts are pack carburized at a temperature range between 1650 and 1700 F, and then quenched from the box in water. Quenching is followed by drawing.

The second method of carburizing proceeds as in the first, except that after the quench the parts are reheated



Some of the free cutting steels require machines with ultra-high speeds to obtain maximum possible output. This five-spindle machine offers speeds from 107 to 1168 rpm.

to 1400 to 1450 F, quenched and then drawn to required hardness.

Hardening — Maximum physical properties are attained in the steels through hardening, but not all free cutting steels can be hardened.

To harden, the parts are heated to between 1500 and 1550 F. If the steel has 0.30% carbon or more it is quenched in oil; under 0.30% carbon, water. Drawing for required hardness follows.

Other heat treating processes can be applied to the free cutting steels, but are not commonly used.

The Bessemer screw stock B1111, B1112 and B1113 can be carburized and cyanided, but the results are not too satisfactory. Where parts must be case hardened, the open hearth steels of similar composition are recommended.

C1117 and C1118 are used extensively for case hardened parts where extensive machining is required.

SAE 1132 is often used in place of SAE 1035 and SAE 1040, where deeper hardening and higher physical properties are desired.

C1137 and C1141 are primarily oil hardening steels and result in deep hardening. They provide higher physicals than SAE 1045 and SAE 1050.

Forming

Although the free cutting steels are not intended for cold forming, it is sometimes desirable to bend, swage or cold head parts made of these steels.

Cold working, which is highly important in achieving free machining qualities in the steel, has the effect of reducing ductility. While favorable to free cutting, the lack of ductility tends to cause cracking in the steel on any but the mildest kinds of forming.

When forming is required it is best to avoid the Bessemer free cutting steels, since these steels are cold short and not at all suited to cold forming. These grades of steel cold work rapidly and are likely to crack at the corners even when the work being done is merely bending to form an angle.

The lower carbon content open hearth free cutting steels are not much better than the Bessemer steels as far as formability is concerned. It is not until a steel of the type of C1115 is used that forming can be recommended. With C1115 simple, bending, broaching and swaging are found to be satisfactory.

Steels C1117 and C1118 are more ductile than those of lower carbon, sulfur and manganese. Therefore, these steels can be subjected to reasonably severe forming processes.

From C1118 on throughout the list of free cutting steels forming is possible to the extent that it is found acceptable in the plain carbon steels.

A reasonably safe rule on which to judge the formability of a free cutting steel is, that as the machinability rating goes down the formability goes up.

Uses of Free Cutting Steels

To make anything like a complete list of applications of free cutting steels would require a book. In general, the parts made of those steels with the best machinability are the type of parts which are not subjected to great stress and shock. In other words, the steels with best machinability are not suited for parts which are to be used in critical service.

In general, parts produced of free cutting steels are rather small, since the vast majority of such parts are produced on automatic screw machines where full advantage of the cutting properties can be used to advantage.

Cold drawn bars are furnished regularly as rounds, squares, flats and hexagons. In addition, shafting and special shapes can be supplied. Shafting can be sold in any one of three conditions: turned and polished; ground and polished; and, turned, ground and polished. When a minor amount of machining is involved, it often pays to buy shafting in any of these conditions, since then no other finishing is required. Cold drawn rounds are furnished in sizes up to 8-in. dia.; hexagons up to 3⅛ in.; squares to 4 in., and flats range from ⅛ to 2½ in. thick and ½ to 12 in. wide.

Typical of the uses of the lower strength (highest machinability rating) free cutting steels is their application as nuts, tubular rivets, studs and screws.

Uses range up to such parts as adapters, universal joints, yokes and crankshafts made out of C1145 and other of the free cutting steels which can be heat treated.

Acknowledgment is made for the assistance given in the preparation of this manual by the following organizations:

American Steel & Wire Co., Cleveland, Ohio
Bethlehem Steel Co., Bethlehem, Pa.
Bliss & Laughlin, Inc., Harvey, Ill.
General Motors Corp., Detroit, Mich.
La Salle Steel Co., Hammond, Ind.
Republic Steel Corp., Union Drawn Steel Div., Massillon, Ohio
Society of Automotive Engineers, New York
Wyckhoff Drawn Steel Co., Pittsburgh, Pa.

NUMBER 167
October, 1948

MATERIALS: Nonferrous Metals
METHODS: Forming and Drawing

Composition and Properties of Nonferrous Alloys for Stampings, Including Deep-Drawn Parts[1]

	BRASSES							
	Copper oxygen free	Comm'l bronze 90%	Red brass 85%	Low brass 80%	Cartridge brass 70%	Yellow brass	Phosphor bronze 8%	Nickel silver (a) 18%
Specification Designation	B101 B152	B36 B130	B36	B36	B19 B36	B36	B103	B122
Nominal Composition, %	Cu, 99.92 min.	Cu, 90.0 Zn, 10.0	Cu, 85.0 Zn, 15.0	Cu, 80.0 Zn, 20.0	Cu, 70.0 Zn, 30.0	Cu, 65.0 Zn, 35.0	Cu, 92.0 Sn, 8.0	Cu, 65.0 Zn, 17.0 Ni, 18.0
Typical Uses	Drawn and stamped parts	Small containers	Badges, dials, hardware	Bellows, drawn parts	Cartridge cases, other deep drawing	Deep drawing, all stamping operations	Springs, bellows, washers, fuse clips	Hardware, lighting and stamped parts
General Properties (c)	High electric conductivity	High ductility	Higher strength and ductility	Similar to red brass	Best combination of ductility and strength any brass	Excellent cold working. Good corrosion resistance	High corrosion and fatigue resistance	High physical and corrosion resistance
Drawing Properties (c)	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Weight Lb. per Cu. In.	0.323	0.318	0.316	0.313	0.308	0.306	0.315	0.316
Tensile-Soft Strength (a)-Hard	32 50	37 61	40 70	44 74	47 76	47 74	55 93	58 85
Elongation-Soft % in 2 In.-Hard	40 5	45 5	47 5	50 7	62 8	62 8	70 10	40 3
Yield-Soft Strength (a)-Hard	8 48	10 54	12 57	14 59	15 63	15 60	— 2	25 74
Hardness Soft Hard	 40RF 50RB	 53RF 70RB	 59RF 77RB	 61RF 82RB	 64RF 82RB	 64RF 80RB	 75RF 93RB	 85RF 87RB

(Continued on page 105)

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R-303

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NUMBER 167 (Continued)

Composition and Properties of Nonferrous Alloys for Stampings, Including Deep-Drawn Parts[1]

	ALUMINUM			MAGNESIUM			ZINC
	Aluminum 2S	Aluminum 3S	Aluminum 52S	Magnesium Dowmetal M	Magnesium Dowmetal J-1	Magnesium Dowmetal FS-1	—
Specification Designation	B25	B79	B109	B90-41T	B90-41T	B90-41T	—
Nominal Composition, %	Al, 99.0 min.	Al, rem. Mn, 1.25	Al, rem. Mg, 2.5 Cr, 0.25	Mg, rem. Mn, 1.5	Mg, rem. Mn, 0.2 Al, 6.5 Zn, 1.0	Mg, rem. Mn, 0.3 Al, 3.0 Zn, 1.0	Zn, rem. (d)
Typical Uses	Reflectors, flashlights, parts	Kitchenware closures, containers	—	—	—	—	Battery cans, jar tops, eyelets
General Properties (c)	Ductile—resists weathering	Ductile—stronger than 2S, good forming	Medium strength, good formability, non-heat-treatable	Best for deep draws, lowest in price	Maximum strength, good drawing and forming	Good drawing, superior forming	High ductility
Drawing Properties (c)	Excellent	Excellent	Good	Excellent when heated	Good when heated	Excellent when heated	Excellent
Weight Lb. per Cu. In.	0.098	0.099	0.096	0.064	0.065	0.064	0.259
Tensile-Soft Strength (a)-Hard	15.5 22	19 27	31 34	33 37	42 45	37 43	18 30
Elongation-Soft % in 2 In.-Hard	15-30 1-4	6-25 1-4	15-20 3-7	17 10	16 9	21 10	60 10
Yield-Soft Strength (a)-Hard	5 21	6 25	14 29	18 29	26 35	21 33	— —
Hardness Soft Hard	(b) 23 Bhn (b) 44 Bhn	(b) 28 Bhn (b) 55 Bhn	(b) 45 Bhn (b) 67 Bhn	55RE 67RE	58RE 73RE	67RE 83RE	52 Bhn 60 Bhn

[1] *Only some of the more important nonferrous alloys employed for stampings are here listed, all of these being well suited for deep drawing when in their annealed state. Almost any nonferrous strip or sheet stock can be used for stampings that are merely blanked and pierced or formed, especially if forming operations are not severe. Some nonferrous alloys not listed are also suited for deep drawing.*

(a) In thousand psi. (b) Bhn 500-kg. load, 10-mm. ball. (c) In general, comparisons apply as among alloys of the same base metal. (d) Commercially pure rolled zinc.

Prepared by Herbert Chase

A Corrosion-Resistant Metal that is strong at RED HEAT

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MATERIALS & METHODS

DIGEST

A selective condensation of articles — presenting new developments and ideas in materials and their processing — from foreign journals and domestic publications of specialized circulation.

Edited by H. R. CLAUSER

Stress-Corrosion of High-Strength Aluminum Alloys

As new light-strength aluminum alloys ve become available, their resistance to rrosion has been determined by the ational Bureau of Standards. In the course this investigation of 75ST, R301T, 303T, and 24ST, methods and apparatus r accelerated laboratory tests of stressed mples in corrosive solutions were devel- ped and applied, and these are now de- ribed in *Journal of Research*, July, 1948, H. L. Logan & H. Hessing. Marine- tmosphere exposure tests of the same ma- rials under similar experimental condi- ons indicate a high degree of correlation etween results of the laboratory tests and hat may be expected in actual service.

In the investigation of the stress-corrosion esistance of these new materials, standard STM flat tensile specimens with ½-in. educed sections were tested both in the aboratory and in a marine atmosphere nder a stress equal to three-fourths of the ield strength. In the laboratory, stressed amples of all alloys were continuously im- mersed in a sodium chloride-hydrogen eroxide solution; those containing zinc as n alloying element (R303-T and 75S-T) ere also exposed in a boiling 6% solution f sodium chloride. Unstressed specimens ere subjected to the same corrosive condi- ions in order that the effect of stress in ncreasing corrosion damage could be eval- uated. All clad materials were tested with he cladding intact since the purpose of the ests was to determine the resistance of the ommercial alloy as actually used rather han that of the core material itself. Losses n ultimate tensile strength and percent longation were taken as criteria of corrosion damage.

The results of the investigation indicate hat flat, bare 24ST aluminum alloy sheet ged 4 hr. or longer at 375 F is not sus- eptible to stress-corrosion cracking in ither the laboratory or marine atmosphere ests, and is at least as resistant to the ombined action of stress and corrosion as he commercially heat-treated but unaged aterial. It was found that aging of a ample of this alloy for 3 hr. at 385 F pro- uced an increase in yield strength of bout 25% above an initial value of ap- roximately 50,000 psi., an increase in ten- ile strength of about 3% above an initial alue of approximately 70,000 psi., and a ecrease of about two-thirds in the initial longation of 17 to 18%.

The samples of the other alloys that were ested, with the exception of R301-T, were ound adequately resistant to stress-cor- osion cracking.

In general, it was apparent that the hort-time laboratory tests developed give a ood indication of the corrosion resistance o be expected of the unclad alloys in a arine atmosphere. However, results of con- inuous immersion tests on clad material in he laboratory do not necessarily agree vith those obtained by exposure in a marine tmosphere.

Some Italian Work on High-Speed Tool Steels

Before the war, the standard high-speed steel in Italy was the 18-4-1 tungsten type, with additions of cobalt for severe service. During the war it was necessary to conserve tungsten, so the Italians adopted three substitute tungsten high-speed steels of approximately the following types: 14-4-2, 12-4-4 and 8-4-2. The first two replaced the cobalt types, while the latter took the place of the 18-4-1. Although the original tests had shown these steels to be equivalent to the older types, practical experience showed that the substitute steels were often inferior. M. Ongaro in the Jan./Feb., 1948 issue of *La Metallurgia Italiana* (Italian) reports on an extensive series of tests comparing these steels with 18-4-1 and 18-4-1 plus 10% cobalt.

Of the most practical value were the turning and milling tests. In both types of tests, the tool performance increased with the hardness for all the steels tested. When the tools were tempered to equal hardness values, however, and when suitable austenitizing temperatures were used (in the turning tests, 2370 F for the low and 2410 F for the high tungsten steels; in the milling tests, 2335 and 2370 F, respectively), there was no noticeable difference in the performance of the various types of high-speed steels.

Regardless of the type of steel, the optimum hardness must be determined for each specific tool. The low tungsten steels require more careful and precise heat treatment than do the high tungsten steels. The carbon-vanadium ratio of the low tungsten steels must be closely controlled for best results. The general conclusion is that the cobalt high-speed steel will undoubtedly give the highest performance in finishing operations conducted under the best cutting conditions. Yet, in many cases, the low tungsten steels will give performances practically equal to those of the more expensive high tungsten steels.

Bronze Coating Steel Wheels

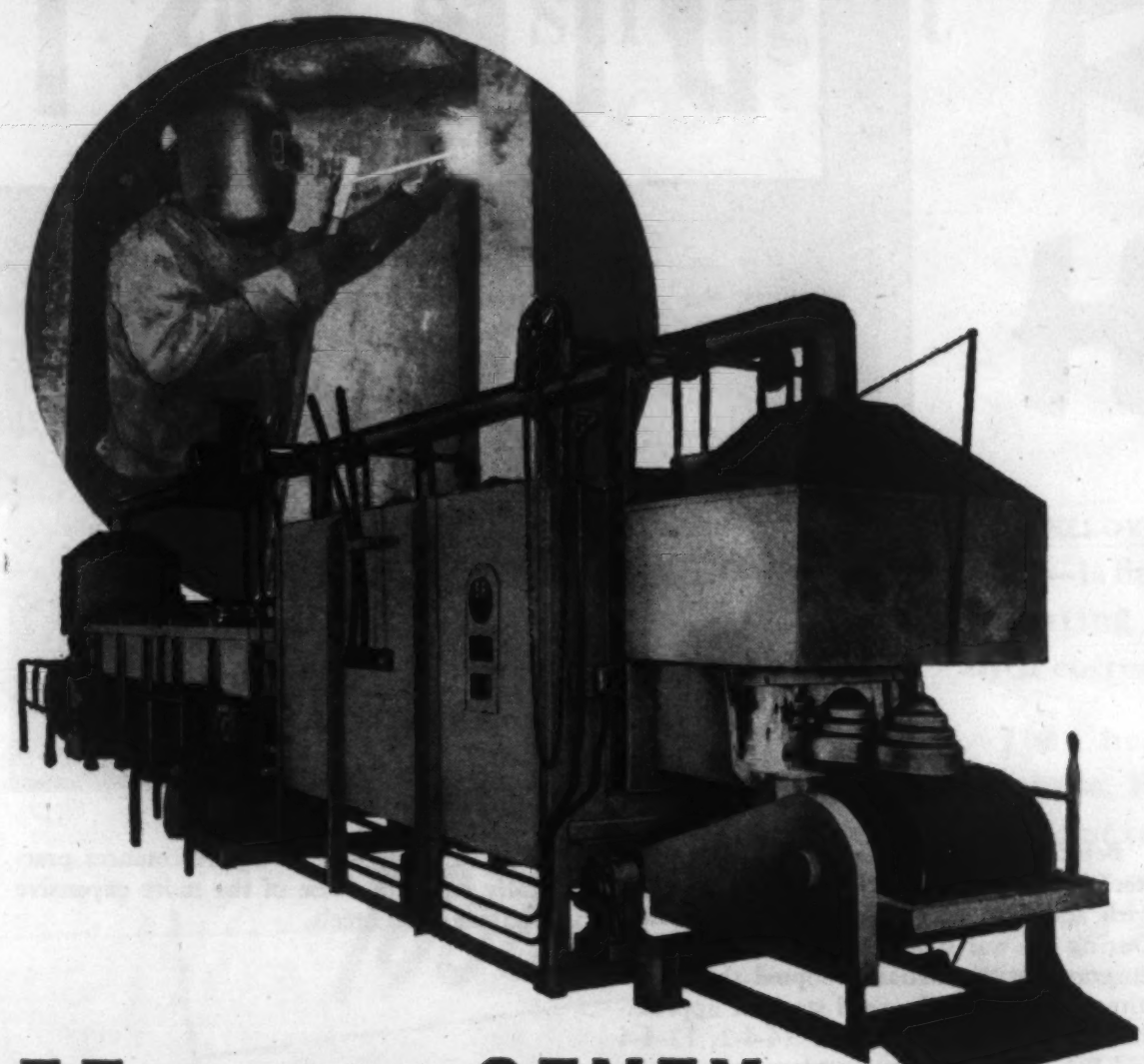
Shortage of tin in Germany during the war led to the development of coating steel gear wheels with bronze by a special casting process. Two reports available from the *Office of Technical Services, Dept. of Commerce* ("German Non-Ferrous Foundry Industry" and "Bronze Coatings on Steel Gears in Germany") describe this development.

Although production was more expensive, the Germans claimed that bronze-lined gears had greater strength, longer life, and were generally superior to solid cast gears, especially for military equipment where great shock was exerted.

At one German firm a process for producing bronze-coated steel gear wheels for back axle worm wheels was started in 1937. In solid bronze the life of the wheels was said to be as low as 30,000 miles; this was raised to 60,000 miles by the adoption of bronze-coated steel worms. The process was developed on a large scale during the war to conserve nonferrous metals.

A special bronze was used for the coating. Gas heated furnaces were used for the melting. The gear was placed in a grey cast iron mold lined with fireclay. A heavy iron ring was placed on top of it. The bronze was cast into the annulus between the gear and the container. After cooling,

For GAS TIGHT WELDS at HIGH SPEEDS...



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DIGEST

the gear with attached bronze coating was removed and packed in a graphite sand mixture. This was followed by diffusion heat treatment and final machining.

A New Microhardness Tester

The impressions made by the ordinary hardness testers are usually large in relation to the microstructure of the specimen. The desirability of a form of hardness test that can be applied to a small selected area is shown by the various microhardness testers developed in the past few years. A new type is described by E. W. Taylor in the June, 1948 *Journal of the Institute of Metals* (English).

The indenter is a Vickers diamond pyramid; thus, the hardness figures obtained correspond very closely to standard Vickers or Brinell values, regardless of the load used. The load, which may be varied from 1 to 500 g. according to the material tested, is applied by means of weights. The microhardness tester is attached to the mechanical stage of a microscope, preferably of the inverted type. It can be used to make either single hardness impressions or a scratch test. The indenter can be positioned so as to produce the impression precisely at a pre-determined point.

Examples are given of the use of this hardness tester to determine the hardness of the individual microconstituents in various ferrous and nonferrous metals, as well as the depth-hardness curve of nitrided steel. In addition, the tester has been used to advantage in the testing of thin sections of metal, such as razor blades, nickel plate and tin foil, which do not lend themselves to the more usual methods.

Increasing Fatigue Strength by Cold Rolling

The cold rolling of highly stressed surface areas has been used considerably to increase the fatigue strength. It is preferred to shot peening for heavy parts, such as railroad equipment. The rolling conditions have generally had to be determined for each part on the basis of experience. A paper by O. Föppl (No. 40, 1948) issued by the Mitteilungen des Wöhler Instituts (German) proposed a means of predicting these conditions.

The results of the rolling can be expressed by the depth of the plastically deformed layer and the maximum stress of

the outer layer. They depend to a large extent on the properties of the steel being worked. Presumably factors other than hardness may affect them, but until more information is available it may be assumed that the pressure used in rolling should vary in proportion to the hardness of the steel. The depth of the deformed layer will increase in proportion to the square root of the rolling pressure.

To obtain the same stress pattern, the depth of the deformed layer should vary in proportion to the diameter of the part. Actually, however, the main effect of the rolling is not so much the plastic deformation of the outer layer as it is the smoothing out of the surface imperfections. These imperfections do not increase with the diameter but at the most with the square root of the diameter. Therefore, if a certain depth t_1 of the deformed layer has been found satisfactory for a part with the diameter D_1 the depth t_2 for a bar with the diameter D_2 would be $t_2 = t_1 \sqrt{D_2/D_1}$. Unless there are more precise data on the type of part in question, it can be assumed that the depth of the deformed layer should be at least 0.01 in. for a diameter of 2 in.

Aluminum Alloy Casting Developments in France

The development of the present alloys, improvements in casting practice and the expansion of the fields of application of aluminum alloy castings are reviewed by E. G. West in the June 24 and July 1, 1948 issues of *Foundry Trade Journal* (English).

One primary objective of recent research is the eventual production of alloys with better weldability. This is of interest to foundrymen, since there are indications that there may be a common solution to both welding and casting problems. Attention is also being directed to improvements in the casting characteristics and mechanical properties resulting from small additions of various elements—*e.g.* cobalt to the 12% silicon alloy. Since another fundamental contribution has shown that the modulus of elasticity can be increased 25% by alloying, it is possible that casting alloys may be developed which will allow section for section replacement of cast iron for equal rigidity and at least equal strength.

The general trend of aluminum casting technique has been in the direction of lower production costs and greater accuracy. Particularly valuable developments are the low-pressure and vacuum techniques. An improvement in quality has been linked with the widespread introduction of radio-

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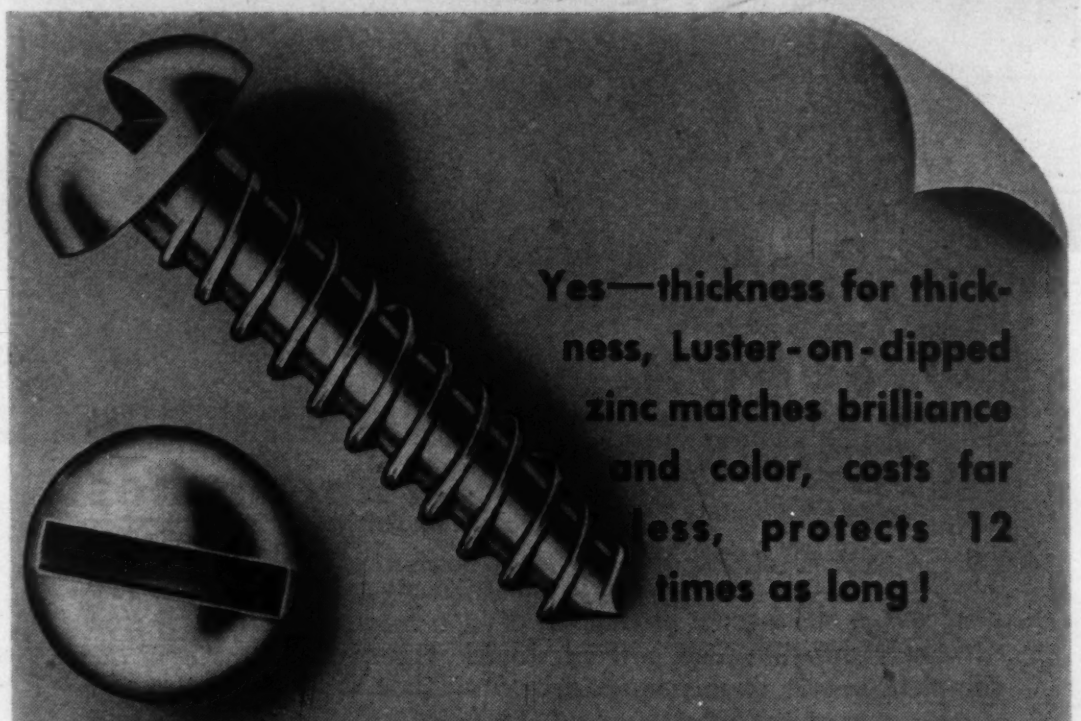

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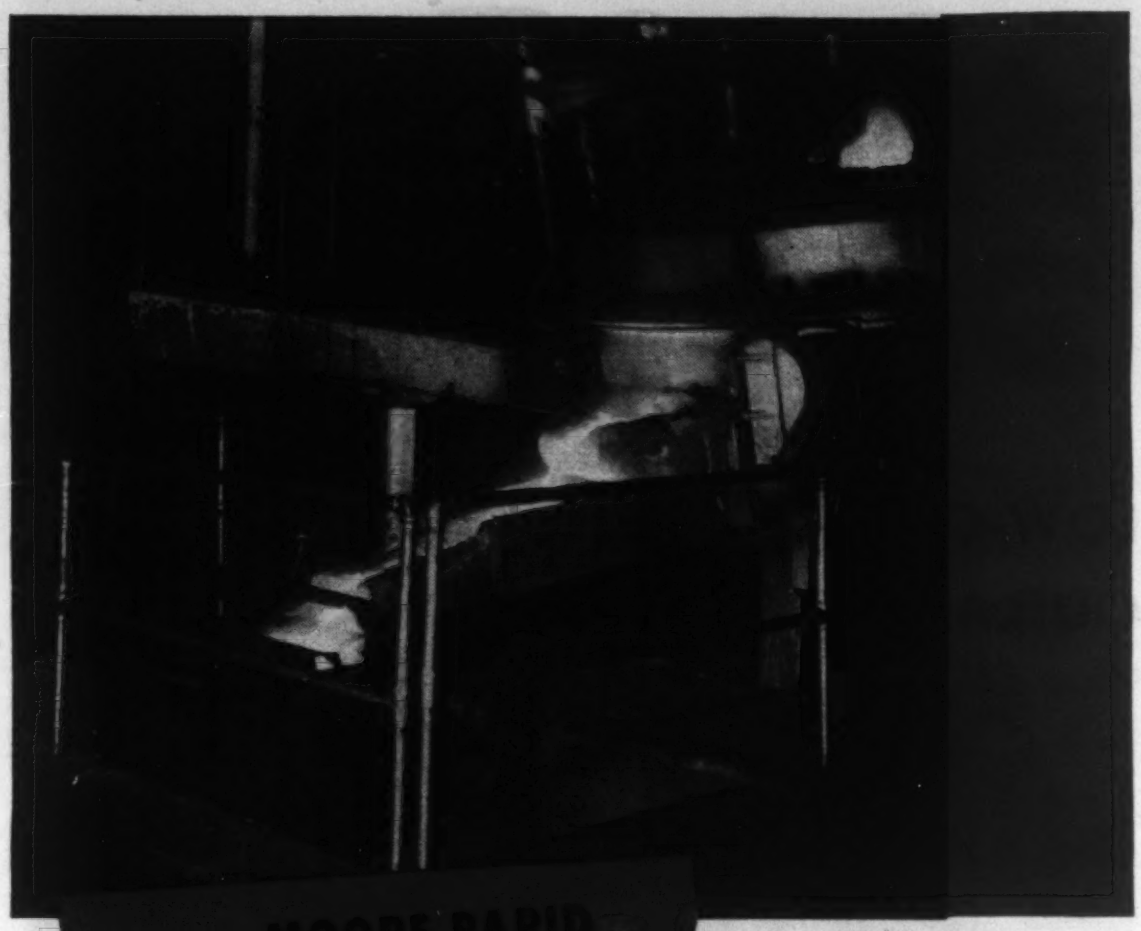

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DIGEST

graphic examination as a standard inspection procedure for high duty castings. Radiography has further become an essential tool in the development of economical production practices even though the bulk of the run may not be so inspected. In the future, more attention should be devoted to reducing costs by the adoption of continuous melting and casting procedures.

The expansion of the uses of aluminum castings is following the general extension of aluminum into every branch of engineering, including especially transport, machine tool, building and domestic. Care must be and is being taken to avoid the mere short-term substitution of aluminum for materials which are in short supply but which would normally be more economical. Rather, emphasis must be placed on the many long-term possibilities where aluminum is economically and technically the best choice.

Contact Arc and Spot Welding

One of the critical factors in arc welding processes is manipulation of the electrode and keeping it from touching the work piece during welding. During the past few years considerable work has been done in Holland on the development of electrodes which are deposited by actually contacting the work piece. Description of this method of welding, called contact arc welding, is given in an article by P. C. van der Willigen and G. Zoethout in *The Welding Journal*, Aug., 1948.

Relatively heavily coated electrodes are required for contact welding. The coating is made thicker by incorporating a large amount of iron powder with the flux ingredients. In many cases faster welding speeds can be achieved with contact electrodes. Also, the current and voltage are less subject to irregularities in the motion of the welder's arm, since arc length is determined by depth of the cup at the tip of the electrode and to a lesser extent by the angle between the electrode and the work-piece. Thus, the net result of constant arc length as well as constant travel speed is deep and uniform penetration.

Because contact electrodes do not freeze on touching the work piece, they can be used for contact arc spot welding. Sheet metal from 1/32 in. to ⅛ in. in thickness has been welded with excellent results. It is possible to weld a thin upper sheet to a thick bottom sheet, *e.g.* a 20-gage sheet to a ½-in. plate without difficulty.

A good contact between the plates to be spot welded is, of course, essential. The electrode is placed perpendicularly on the top sheet. The arc starts and then the electrode is lightly pushed through the top

plate into the bottom plate. The tip of the electrode passes through the molten spot in the upper sheet and comes in contact with the bottom plate. As soon as the interfaces are in a molten state, the electrode is withdrawn and the void is filled up with a light quick motion. The entire procedure takes 1 or 2 sec. The technique is rather simple, but its rapidity requires some experience to insure the best results.

Chemical Coloring Zinc Alloys

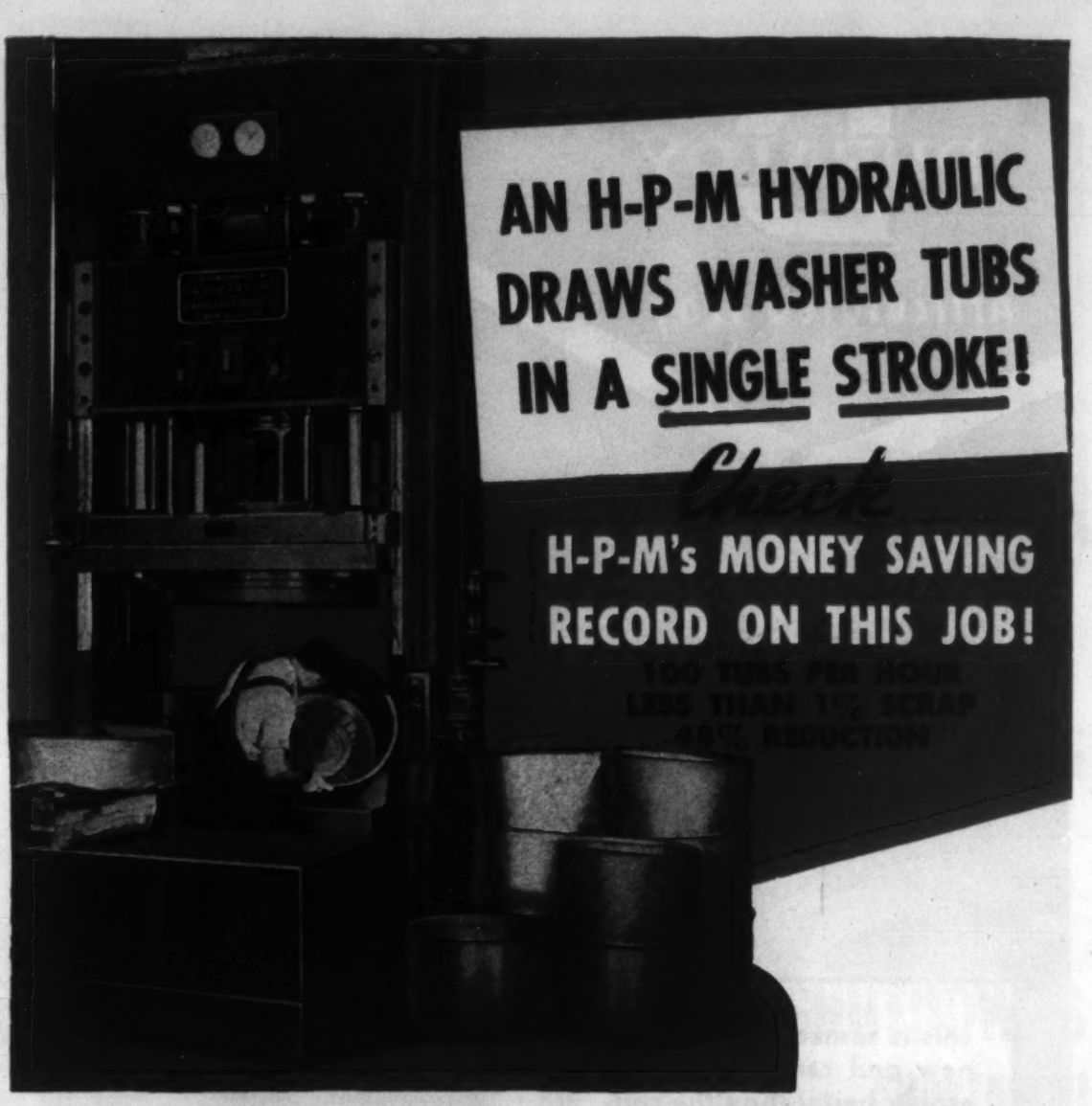
For most commercial applications of zinc alloys, some finishing treatment is necessary to prevent tarnishing. A chemical coloring method that gives an attractive finish is described by W. C. Coppins in the June 11, 1948 issue of *Metal Industry* (English).

The zinc is immersed for two minutes in 20% sodium hydroxide at 160 F, washed, then treated for one minute in a solution of 10% ammonium molybdate and 20 to 25% ammonia at 175 F and washed. The depth of color depends on the ammonia concentration of the molybdate bath and the time of immersion. With the bath composition given, the surface of the zinc assumes a dark green, rich, lustrous appearance. If the treatment in both baths is repeated, a jet black surface is obtained. A preliminary polish is not required for the black finish although it certainly improves the appearance. Polishing is essential, however, if an attractive colored effect is desired.

Since the surface film is very thin, it is not satisfactory for parts that will be subject to abrasion. On the other hand, it does provide some protection against corrosion, with the thicker black film better than the thinner films. If the process is modified by the substitution of sodium zincate for sodium hydroxide, it can be used for aluminum alloys.

High Temperature Bolting Materials

A report prepared by E. L. Robinson and presented before the recent June meeting of the American Society for Testing Materials gives much valuable information on bolting materials for high temperature service ("High Temperature Bolting Materials"). The report brings together performance data including relaxation or bolting strength on a series of materials ranging from plain carbon steel to alloys suitable



Imagine drawing 19 gauge steel to a depth of 15 5/16" with a single press stroke! From a blank size of 44¼" dia. to a 23" dia. tub is a reduction of 48%. Spectacular? You bet it is... and what's more, this H-P-M press owner* has less than 1% scrap loss, even with today's irregular stock! The tub bottom is embossed in the same operation. Production of 100 tubs per hour is a record, too!

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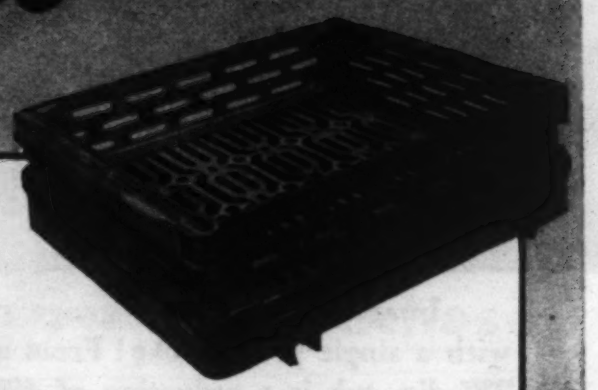

This is something relatively new and certainly considerably better than the conventional one piece tray.

1 . . . rigid corners have been eliminated

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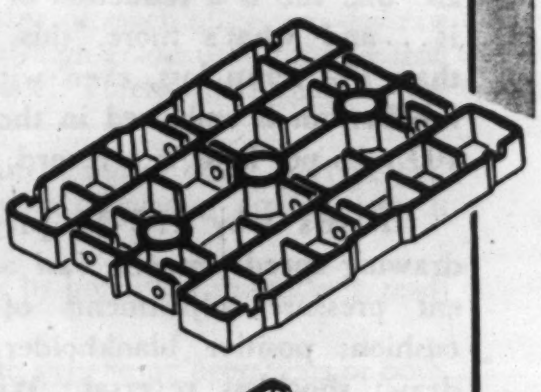

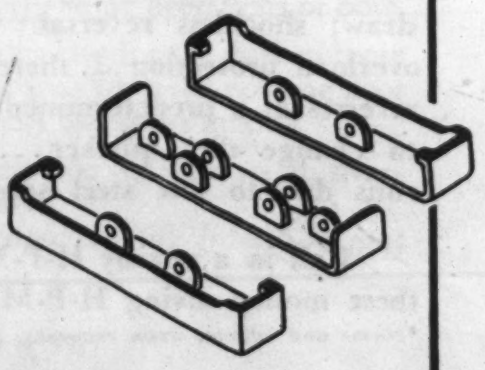

If you require heat-treating trays in your plant, why not investigate the Duraloy Articulated Tray*? The principle of design permits wide variations in size and shape. Send us a sketch or description of your present trays and we'll design a Duraloy Tray to take its place and let you know what it will cost.

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DIGEST

for bolting flanges at metal temperatures of 1000 to 1500 F.

The materials fall into three groups: (1) moderate temperature materials such as carbon and chromium-nickel steel (2) high-temperature ferritic materials containing tungsten, molybdenum, vanadium in various amounts with or without chromium; (3) high-alloy materials which may or may not contain iron.

The high-alloy materials may have a coefficient of thermal expansion about 50% higher than in the ferritic materials. It is necessary to keep this in mind in choosing a bolting material. Unless the bolt and the flange have approximately the same thermal expansion, trouble may result. Another point to remember in selecting the bolt material and in designing the bolt, is that bolts that perform as intended and stay tight do so because they are strong enough to resist relaxation. Initial stresses always tend to relax, and at any time before the next overhaul the residual stress should be well above the design value in order to preclude any possibility of leakage.

High Alloy Steels with Nitrogen Additions

With the present tight nickel supply, it is timely to consider the possible substitution of nitrogen for part of the nickel in austenitic steels. In this country, nitrogen has been added to the high chromium ferritic steels, but little attention has been paid to the addition of nitrogen to austenitic steels. H. Schottky, in the Apr., 1948 issue of *Zeitschrift für Metallkunde* (German), summarizes the German work, which was carried out with the aim of saving nickel and improving the properties.

In spite of the extensive investigations, a widespread commercial use of austenitic steels with nitrogen did not develop, partly because nitrogen containing ferroalloys were not readily available. The production of these steels is not difficult if the ratio of nitrogen to chromium is under 1:75 and if the high nitrogen ferroalloy is not added until the rest of the manganese and chromium have been dissolved in the steel bath.

The addition of about 0.2% nitrogen made it possible to decrease the nickel in "18:8" to about 4 to 5.5% and still to retain an austenitic structure. Nitrogen additions were made to other austenitic steels, including both chromium-nickel and chromium-manganese steels. In austenitic and austenitic-ferritic steels, the nitrogen increased the 0.2% yield strength markedly

and, to a lesser extent, the tensile strength with little change in the working properties. The hot, tensile strength was also increased.

The nitrogen had little effect on the scale resistance, embrittlement on long holding at elevated temperatures, weldability or general corrosion resistance. Improved resistance to pitting, however, was shown by a steel with 23 chromium, 4% nickel and nitrogen, which was one of the suggested substitutes for 18:8. The creep strength was considerably improved in special cases by the further addition of elements, such as vanadium, which combined with the nitrogen to cause precipitation hardening.

Vacuum Deposition of Alloys

While vacuum deposition of pure metals has been successfully done for some time, difficulties have been encountered in the deposition of alloys from high vacuums. A major one is that the condensed alloy obtained from the evaporation of an alloy sample may be quite different in composition from the original one. L. Harris and B. M. Siegel have now developed a method which eliminates this difficulty and which promises to be generally applicable to all alloys whose components can be evaporated. The process is described by them in the *Journal of Applied Physics*, Aug., 1948.

The procedure is to evaporate a few finely divided particles of the given alloy almost instantaneously and continue this process until sufficient alloy has been deposited. This is accomplished by dropping the powdered alloy, a few grains at a time, into a refractory boat heated well above the temperature required to evaporate completely the alloy components. Thus, a vapor phase is established which has the same composition as that of the original alloy.

In developing the method, binary alloys were used in which the vapor pressures, at all temperatures, for the two components are widely different. The alloys were from the copper-zinc system and a gold-cadmium alloy. Chemical and electron diffraction analyses on the evaporated brass alloys and chemical analysis on the evaporated cadmium-gold alloy showed that a composition of the original alloy was held to within close limits.

The method should prove useful in the production of special photo-emissive surfaces, of thin strips of alloys having special electrical properties such as abnormal temperature coefficients of resistivity, and in fundamental studies of the properties of alloys.

OIL STANDBY EQUIPMENT

INSURES AGAINST PLANT SHUTDOWNS

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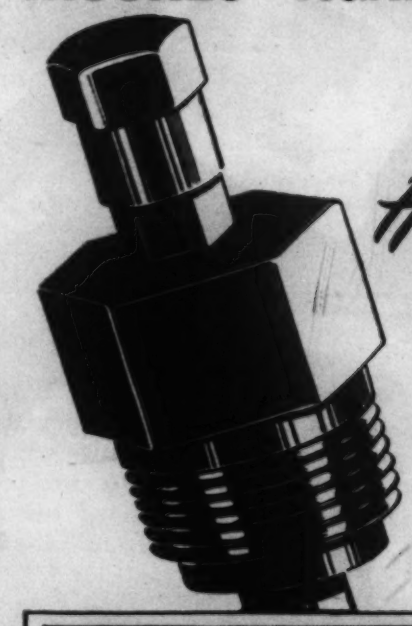

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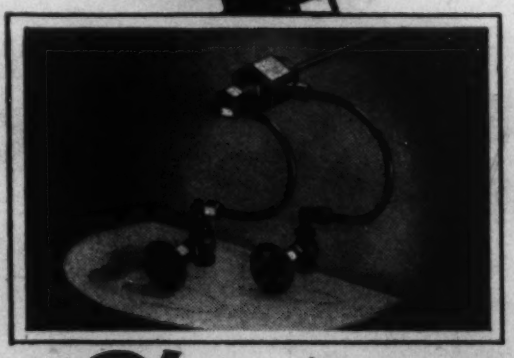

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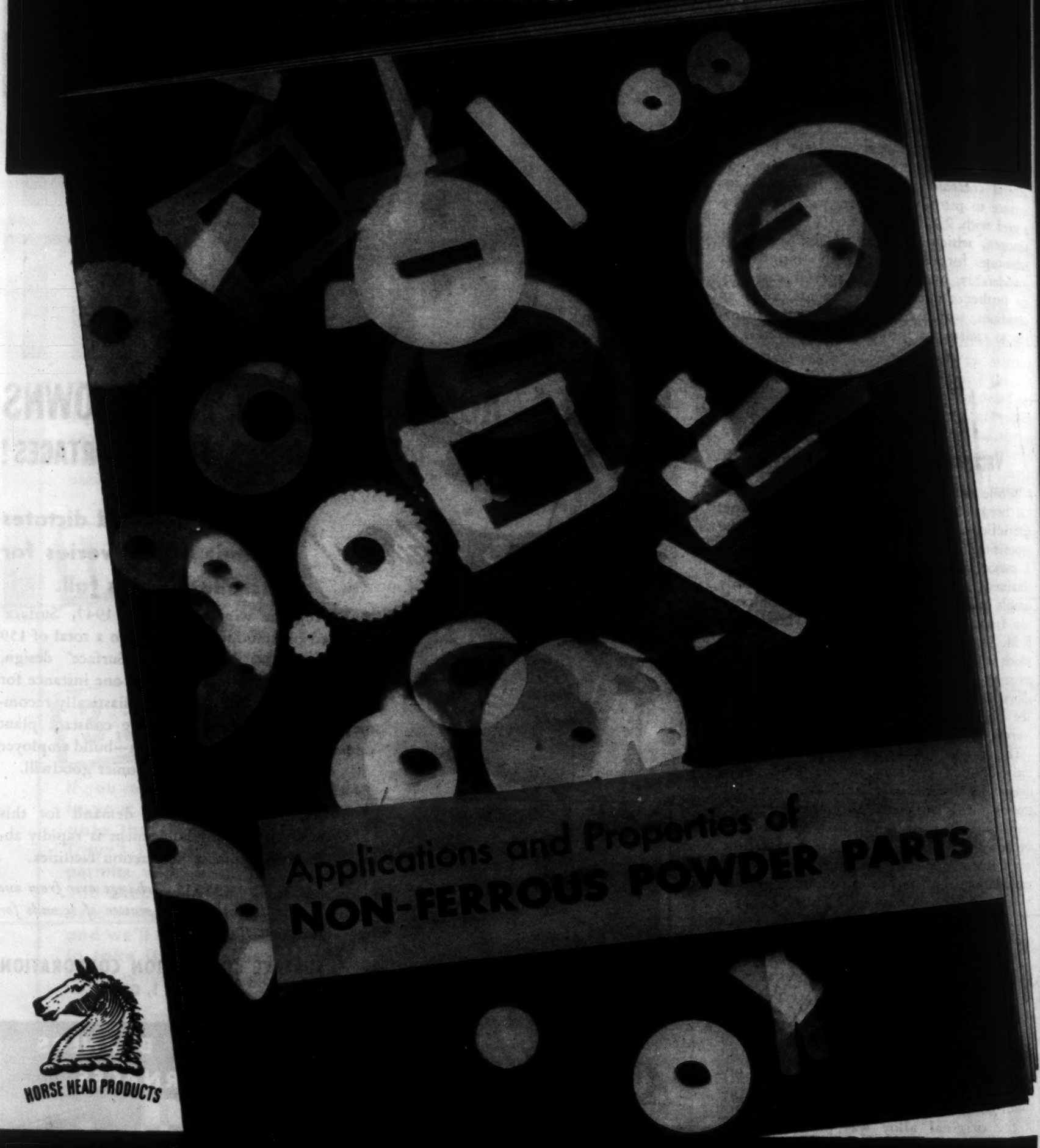

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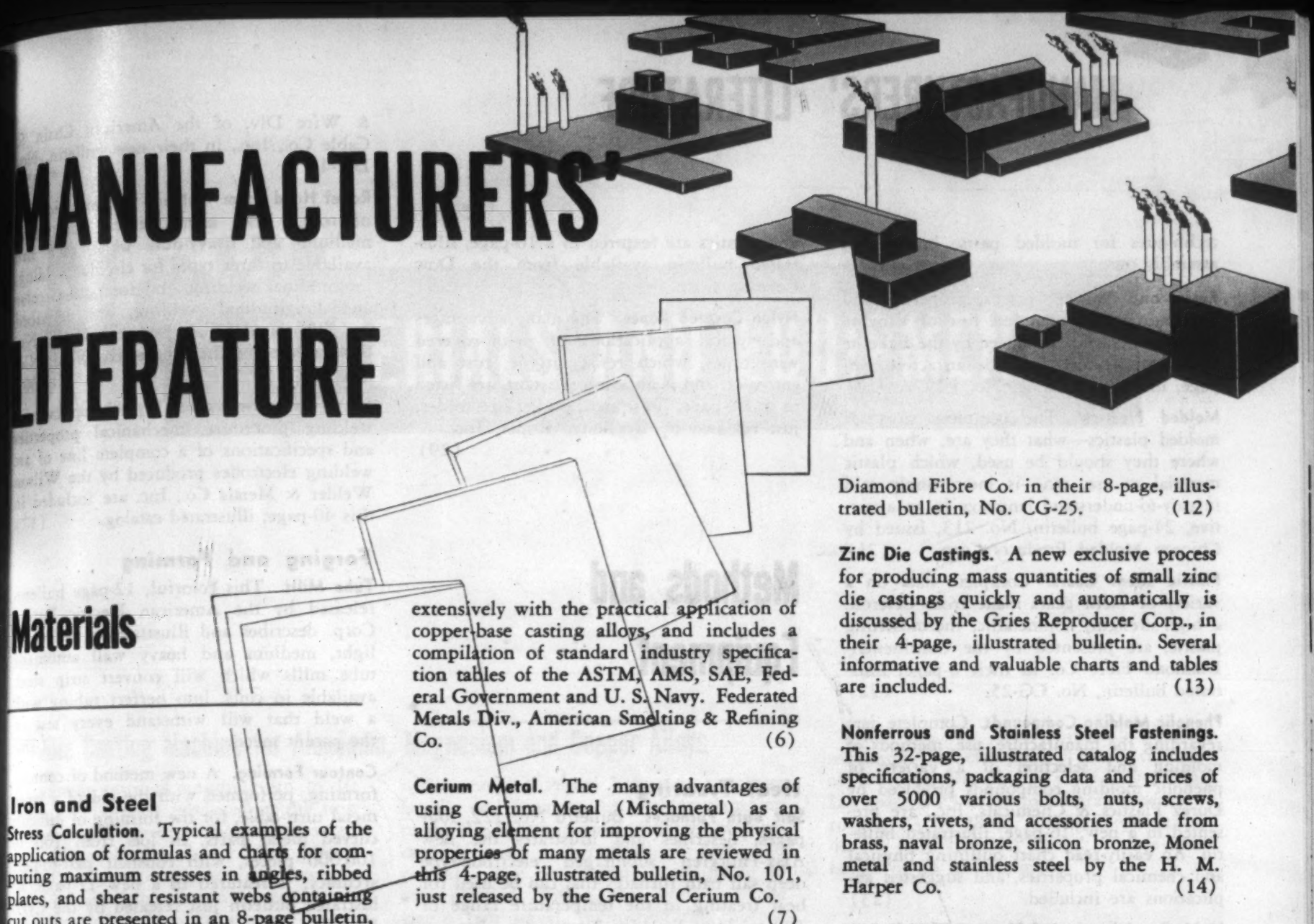


Materials

Iron and Steel

Stress Calculation. Typical examples of the application of formulas and charts for computing maximum stresses in angles, ribbed plates, and shear resistant webs containing cut outs are presented in an 8-page bulletin, No. 27, and its 20-page supplement published by the Meehanite Metal Corp. (1)

Free Cutting Machinery Steel. Mechanical properties, hardness tables and typical applications of Rytense AA, a medium carbon-manganese free cutting machinery steel supplied in hot rolled and cold finished rounds and forged rounds, are included in this 4-page, illustrated bulletin offered by Joseph T. Ryerson & Son, Inc. (2)

Nonferrous Metals

Hard Facing Alloys. Informative data on typical uses, specifications, application technique, deposit hardness, color markings and deposit analysis of a complete new line of Airco hard facing alloys, produced by the Air Reduction Sales Co., are presented in a 16-page, illustrated bulletin. (3)

Bronze Die Alloys. Three grades of aluminum-bronze die alloys for forming and drawing dies are discussed by Ampco Metal, Inc. in their 8-page, illustrated bulletin No. 96. Typical applications and physical properties are included. (4)

Copper-Base Alloys. Complete data on five copper-base alloys—Nos. 601, 602, 603, 606, and 607—for electrical and mechanical applications other than resistance welding, available in bars, rods, slabs, sheet, coiled strip and fabricated parts, are presented in five sets of technical data sheets, each two or three pages, published by the Fansteel Metallurgical Corp. (5)

Copper-Base Casting Alloys. This 52-page, illustrated catalog, No. 102, deals rather extensively with the practical application of copper-base casting alloys, and includes a compilation of standard industry specification tables of the ASTM, AMS, SAE, Federal Government and U. S. Navy. Federated Metals Div., American Smelting & Refining Co. (6)

Cerium Metal. The many advantages of using Cerium Metal (Mischmetal) as an alloying element for improving the physical properties of many metals are reviewed in this 4-page, illustrated bulletin, No. 101, just released by the General Cerium Co. (7)

Lead-Base Babbitt. Complete data on the high lubricating qualities of Grac, a graphitized lead-base anti-friction alloy produced by the Graphitized Alloys Corp., including a lubrication-test chart, directions for use and field of application, are presented in this 6-page folder. (8)

Bearing Metals. Physical characteristics and recommended applications of a variety of tin-base and lead-base bearing metals produced by the Magnolia Metal Co. are included in this 8-page, illustrated bulletin. (9)

Tin Content Indicator. The method of determining the tin content of a solder batch through the use of the Model 2870 tin content indicator is discussed in a 4-page, illustrated bulletin, No. 8, and specifications, operation and prices of this model are featured in a single-page bulletin, No. D700-1, both bulletins just released by the Wheelco Instruments Co. (10)

Parts and Forms

Forgings. The facilities of the Champion Forge Co., one of the first eight in tonnage capacity, for producing various types of forgings, including their facilities for steel storage and handling, die making, production forge shops, heat treating and quality control, are featured in this 12-page, illustrated bulletin. (11)

Plastic Silent Gears. Complete data on a variety of silent gears made from Celeron, a high-strength, nonmetallic, thermosetting plastic, are presented by the Continental-Diamond Fibre Co. in their 8-page, illustrated bulletin, No. CG-25. (12)

Zinc Die Castings. A new exclusive process for producing mass quantities of small zinc die castings quickly and automatically is discussed by the Gries Reproducer Corp., in their 4-page, illustrated bulletin. Several informative and valuable charts and tables are included. (13)

Nonferrous and Stainless Steel Fastenings. This 32-page, illustrated catalog includes specifications, packaging data and prices of over 5000 various bolts, nuts, screws, washers, rivets, and accessories made from brass, naval bronze, silicon bronze, Monel metal and stainless steel by the H. M. Harper Co. (14)

Nickel Alloy Parts and Accessories. A complete line of bearings, solid balls, floats, castings, fastenings, rivets, tubing, pumps, valves, etc., made from corrosion-resistant Monel, nickel and Inconel alloys, produced by the International Nickel Co., Inc., is described and illustrated in this 24-page catalog. (15)

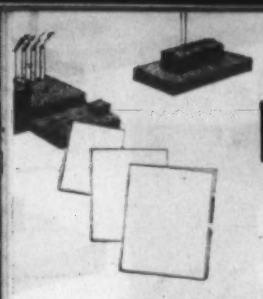
Die Casting Process and Uses. A well illustrated, step-by-step picture and story treatment of die casting with zinc, Zamak 5, aluminum and brass alloys, and the many applications of this die casting process, are presented by the Los Angeles Die Casting Co. in their new, 8-page bulletin. (16)

Plastic Tubing and Fittings. Technical data and physical properties of a complete line of Mills-Plastic tubing and S.A.E. type fittings that are adaptable to a wide variety of applications are featured in this 6-page, illustrated folder offered by the Elmer E. Mills Corp. (17)

Transportation Map. A complete and factual transportation map of the United States, which includes highways, railroads, airlines, principal cities, towns and villages, is offered by the Wolverine Tube Div. of the Calumet & Hecla Consolidated Copper Co. (18)

Plastics

Hard Rubber and Plastics. The first edition of a valuable new 56-page, illustrated handbook on Ace hard rubber and plastics, produced by the American Hard Rubber Co., contains physical and electrical properties, tables of tolerances, weights and standard sizes for sheet, rods and tubes, design



MANUFACTURERS' LITERATURE

techniques for molded parts, inserts and assembly, etc. (19)

Resins and Plastics. Forms, properties and applications of a complete line of Vinylite resins and plastics, produced by the Bakelite Corp., are featured in this attractive, 38-page, illustrated catalog, No. J-547a. (20)

Molded Plastics. The complete story of molded plastics—what they are, when and where they should be used, which plastic material to use, etc.—is interestingly told in easy-to-understand language in an attractive, 24-page bulletin, No. 213, issued by Chicago Molded Products Corp. (21)

Plastic Silent Gears. Complete data on a variety of silent gears made from Celeron, a high-strength, nonmetallic, thermosetting plastic, are presented by the Continental-Diamond Fibre Co. in their 8-page, illustrated bulletin, No. CG-25. (22)

Phenolic Molding Compounds. Complete data regarding the manufacture, use, methods of molding and selection of a variety of phenolic molding compounds produced by Durez Plastics & Chemicals, Inc., are presented in a new, 16-page, illustrated bulletin. An easily-read chart outlining physical and chemical properties, and suggested applications are included. (23)

Molded and Laminated Plastics. The design, mold making and molding facilities of the General Electric Co.'s plastics division for producing a variety of molded and laminated plastics are discussed in this 16-page, illustrated bulletin, No. CDP-578. Detailed tables of general properties are included. (24)

Plastic Tubing and Fittings. Technical data and physical properties of a complete line of Mills-Plastic tubing and S.A.E. type fittings that are adaptable to a wide variety of applications are featured in this 6-page, illustrated folder offered by the Elmer E. Mills Corp. (25)

Plasticizer. This 12-page bulletin, No. P-104, contains detailed data on HB-40, a relatively nontoxic, high-boiling, colorless liquid for use in plasticizing polystyrene casting resins and plastics emulsions, including adhesives, plastics paint coatings and extrusions. Phosphate Div., Monsanto Chemical Co. (26)

Nonmetallics

Hard Rubber and Plastics. The first edition of a valuable new 56-page, illustrated handbook on Ace hard rubber and plastics, produced by the American Hard Rubber Co., contains physical and electrical properties, tables of tolerances, weights and standard sizes for sheet, rods and tubes, design techniques for molded parts, inserts and assembly, etc. (27)

Silicone Mold Release Agents. General properties of a variety of DC silicone mold release agents, as well as major applications of these agents in the fields of lubricating tire molds and curing bags, and in the lubrication of mechanical rubber goods, floor tile and plastics are featured in a 16-page, illustrated bulletin available from the Dow Corning Corp. (28)

Nylon-Covered Ropes. The many advantages and typical applications of nylon-covered wire ropes, which resist fatigue, rust and corrosion and is abrasion-resistant, are listed in this 8-page, illustrated, pocket-size folder, just released by Rochester Ropes, Inc. (29)

Methods and Equipment

Heat Treating

Salt Bath Furnaces. Bulletin No. 122, four pages, describes and illustrates the new Ajax-Hultgren submerged electrode-type deep salt bath furnaces that can be used for heat treating in the temperature range of 300 to 2400 F. Ajax Electric Co., Inc. (30)

Temperature Controls. A large variety of custom-built or production models of temperature control instruments for every type of application are described and illustrated in this 8-page bulletin, issued by the Burling Instrument Co. (31)

Clean Hardening Furnaces. Both continuous and batch types of clean hardening heat treating furnaces that can be used for clean hardening, gas carburizing, carbon restoration, homogeneous carburizing, dry cyaniding, suspended carburization, clean annealing, etc. are featured in this 4-page, illustrated bulletin, No. SC-138, issued by the Surface Combustion Corp. (32)

Welding and Joining

Hard Facing Alloys. Informative data on typical uses, specifications, application technique, deposit hardness, color markings and deposit analysis of a complete new line of Airco hard facing alloys, produced by the Air Reduction Sales Co., are presented in a 16-page, illustrated bulletin. (33)

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Hard Surfacing Electrodes. A complete line of hard surfacing electrodes, each of which provides a weld metal deposit whose particular properties are suited to definite welding applications and are outstanding in their field, is presented by the Page Steel & Wire Div. of the American Chain & Cable Co., Inc., in their new bulletin, No. DH-45. (35)

Roller Head Seam Welders. Three basic sizes of roller head seam welders for light-, medium- and heavy-duty work, each size available in three types for circular welding, longitudinal welding, and for both circular and longitudinal welding, are described and illustrated in an 8-page bulletin, No. 804, released by the Progressive Welder Co. (36)

Arc Welding Electrodes. Typical applications, welding procedure, mechanical properties and specifications of a complete line of arc welding electrodes produced by the Wilson Welder & Metals Co., Inc. are included in this 40-page, illustrated catalog. (37)

Forging and Forming

Tube Mills. This colorful, 12-page bulletin released by the American Electric Fusion Corp. describes and illustrates a variety of light, medium and heavy wall automatic tube mills which will convert strip steel, available in coils, into perfect tubing with a weld that will withstand every test of the parent metal. (38)

Contour Forming. A new method of contour forming, performed with the aid of a large metal turn-table, for the forming of difficult curved metal parts, in lots from 100 to 100,000 pieces, with constant part-to-part accuracy, is featured in a new 12-page, illustrated bulletin just released by the Cyril Bath Co. (39)

Silicone Mold Release Agents. General properties of a variety of DC silicone mold release agents, as well as major applications of these agents in the fields of lubricating tire molds and curing bags, and in the lubrication of mechanical rubber goods, floor tile and plastics are featured in a 16-page, illustrated bulletin available from the Dow Corning Corp. (40)

Laboratory Press. The Hydraulic Press Manufacturing Co. has issued a 6-page folder, No. 4801, describing and illustrating their H.P.M. Smooth Line hydraulic laboratory press for use in many types of applications, including briquetting, tensile testing, extracting, molding, laminating, compression testing, etc., as well as for production work. Specifications are included. (41)

Press Brake Dies, Punching Attachments and Press Brakes. Over 200 press brake dies, ranging from simple bending dies to complex gang punching units, plus a variety of punching attachments and press brakes, produced by the Verson Allsteel Press Co., are described and illustrated in this helpful, 88-page catalog, No. DM-48. Detailed specifications are included. (42)

Machining

Coolant Circulating Pumps. Specifications, head capacity tables, construction and typical applications of various types of foot mounted, submerged and side-wall mounted coolant circulating pumps, produced by the Allis-Chalmers Manufacturing Co., are included in this 8-page, illustrated bulletin, No. 52B6975. (43)

Machine Tools. A complete line of machines for milling, broaching, cutter sharpening,

New MATERIALS AND EQUIPMENT

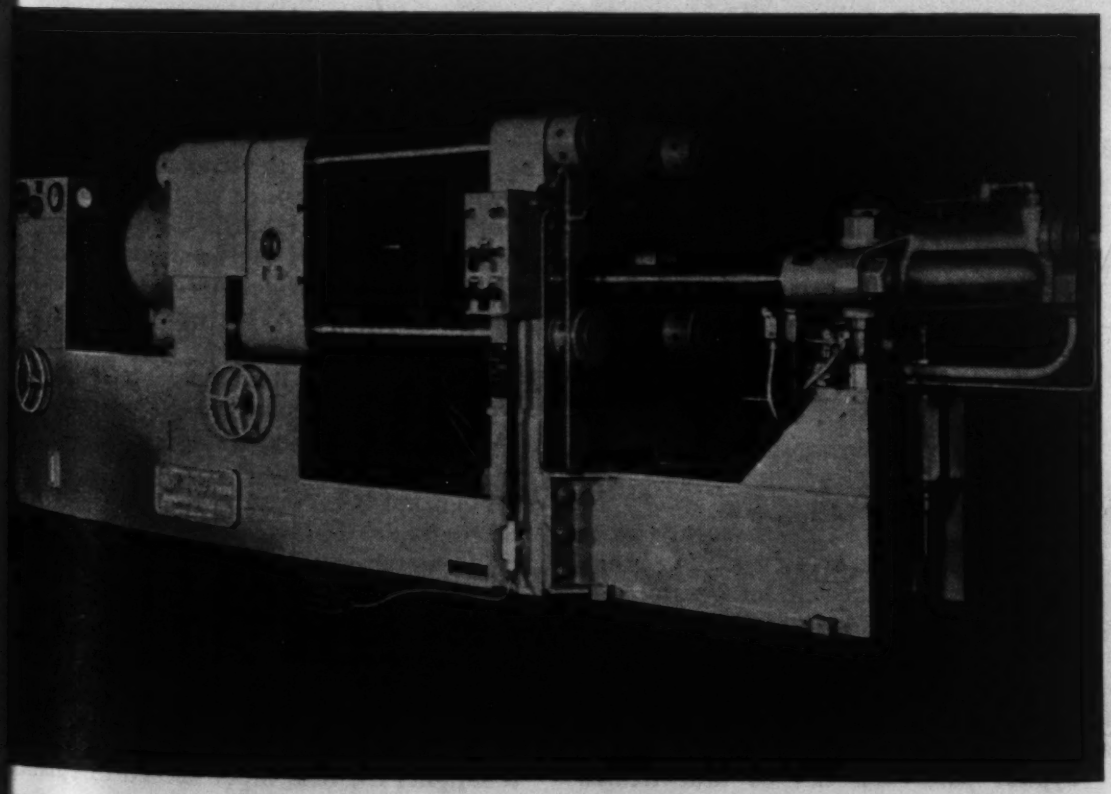
Die Casting Machine for Aluminum, Magnesium and Copper Alloys

Aluminum castings weighing up to 10 lb. each can be mass produced in the new cold chamber die casting machine produced by the *Hydraulic Press Mfg. Co.*, Mount Gilead, Ohio. A typical production example is an intricate 5-lb. aluminum casting of large area produced on an average 40-sec. cycle. This is accomplished through the application of sustained injection pressures through the cold chamber injection system and by confining these pressures, which are high, within the die cavities. This keeps porosity at an absolute minimum.

The machine is a large, self-contained, all hydraulic unit and is suitable for the production of die castings of aluminum-, magnesium- and copper-base alloys. The hydraulic die clamp on the machine, consisting of a double acting ram equipped with a small internal booster ram, closes rapidly and provides for positive clamping of the die halves to assure smooth, uniform castings with a minimum of flash and porosity. The die clamp is adjustable to any position within the limits of the clamp ram travel, permitting the shortest possible opening movement.

The hydraulic injection unit consists of a double acting ram which actuates an injection plunger that delivers molten metal from the cold chamber into the die cavities. An automatic hydraulic ejector is located in the movable die platen. Hydraulic power is available for actuating core pulls. Core movements are controlled by limit switches, offering maximum die protection. Die clamp cannot open until cores are pulled if die requires this action sequence.

This new die casting machine has a maximum die clamping pressure capacity of 400 tons. Die platens are 38 by 38 in. Die space is 23 by 38 in. Clearance between rods is 23 by 23 in. Daylight opening is 42 in. Ram travel is 16 in., with a shut height of 26 in. minimum.



This cold chamber die casting machine is capable of producing large aluminum castings weighing up to 10 lb.

12-Ton Press Designed for Powdered Metals

A new 12-ton capacity press, especially designed for production of powdered metal parts, has been announced by *F. J. Stokes Machine Co.*, 5972 Tabor Road, Philadelphia 20. Typical applications include pressing porous bearings, Alnico, cemented carbides, iron cores, thin-walled bushings, blind end bearings, parts with concentric projections, hemi-spherical shapes, flanged bearings, high-bronze bushings, as well as ceramic parts and carbon mixtures.

The press, designated as G-4 press, is built of special Meehanite, and is capable of applying pressures up to 12 tons simultaneously from both top and bottom. Built into the machine is a movable core rod which can be arranged to drop before the die is filled and then automatically push up from below to assure uniform distribution and a full die cavity before pressure is applied. This core rod can be locked in position to serve as a stationary core rod, capable of withstanding the full 12-ton pressure. The press can be operated with a compound or secondary lower punch, adjustable for stroke or pressure, by a simple cam change.

Maximum die fill is 4 in.; maximum dia. of piece that can be produced is 2¼ in. The press is powered with a 3-h.p. variable speed unit drive, provided with a lever-operated clutch and brake.

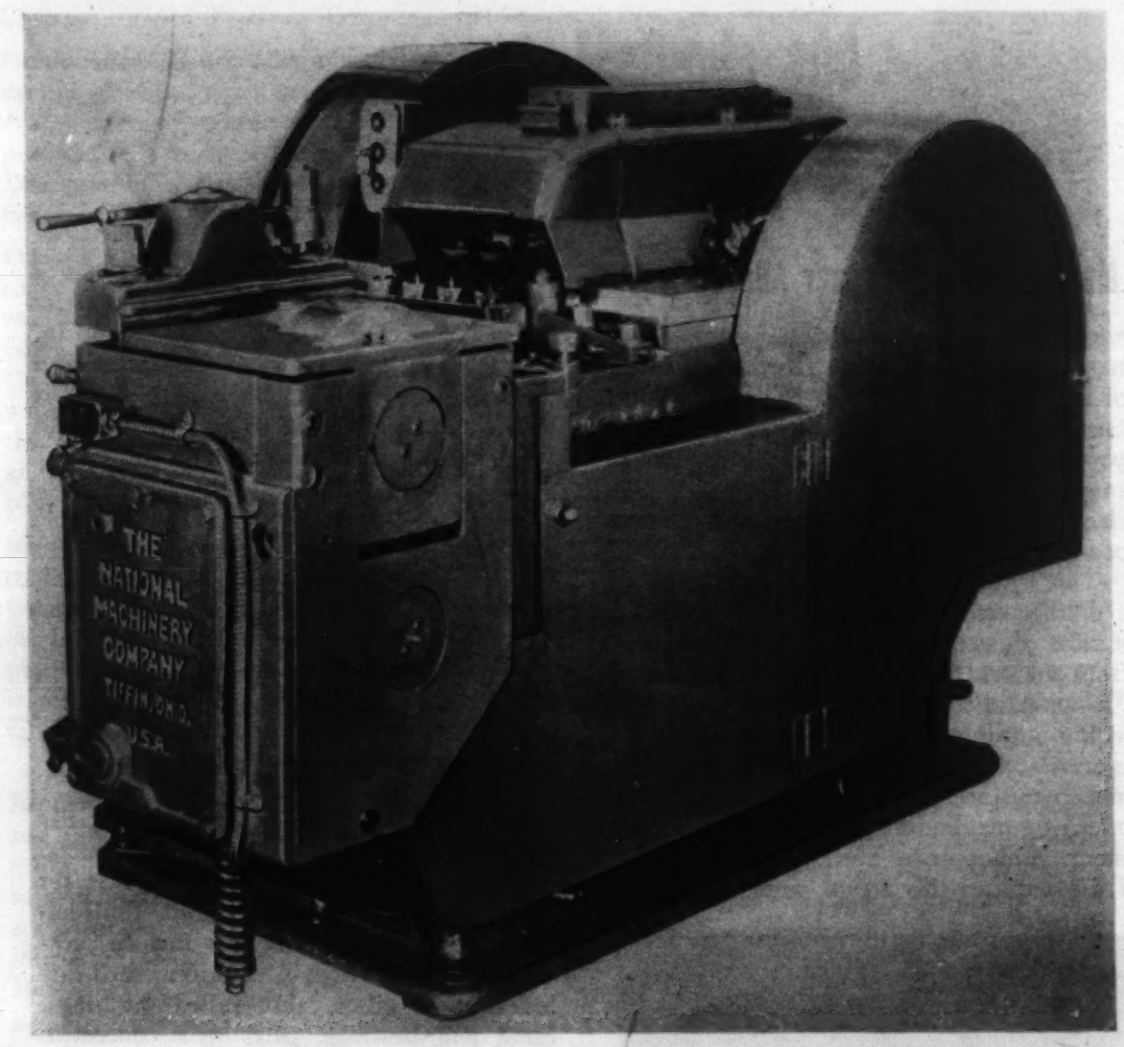
Cold Nut Former Operates on New Principle

Cold nut formers capable of producing a variety of hex nut blanks are now being manufactured by the *National Machinery Co.*, Tiffin, Ohio. Standard single and double chamfered nuts, washer faced nuts, castellated nuts, hug lock nuts, jam nuts, etc. have all been produced on these machines.

Similar to a transfer header in design, the cold nut former utilizes a new principle of operation. Only a minimum of cold forging is done on the blanks until the later operations. Hence, internal stresses caused by early work hardening are avoided, and the finished blanks have typical forging strength and toughness. Minimum working in the early stages is possible because the machines use larger diameter wire or rods than that used in other machines and a shorter length is upset.

Machine features include a short rigid bed frame, patented overarm heading slide, automatic lubrication, and a four-station transfer mechanism which turns the nut blanks 180 deg. after each stroke. All operations (gathering, blanking, forming, and punching) are carried on simultaneously, and the machine produces a complete nut on each stroke. Because the blanks are cold forged to shape, with most of the material from the hole entering the nut, the only waste is a small slug from the hole. Scrap loss is held to between 10 and 15%.

The machines are built in 5/16-, ⅜-, ½-, ⅝-, ¾- and 1-in. sizes. Outputs range from 100 nuts a min. on the 5/16-in. size to 40 a min. on the 1-in. size.



A variety of hex nut blanks can be formed on this machine.

Work Pieces Handled Automatically in New Heat Treating Unit

Heat treating operations are performed automatically in a new unit developed by *Ipsen Industries, Inc.*, 311 Blackhawk Bldg., Rockford, Ill. The unit consists of a batch-loading automatic furnace connected and sealed to an automatic quenching tank.

In operation, a trayful of parts are placed in the furnace. Timers are set for the heating cycle, and for the quenching or cooling time. A selector switch is set for either oil quenching or air cooling. When heating cycle is completed, an intermediate door momentarily lifts to allow the tray to pass into the cooling chamber and be oil quenched if so selected. Upon completion of quenching or cooling time, a light signals that work is ready for removal.

Typical parts that can be heat treated with atmosphere in this unit are shafts, gears, springs, tools and dies, and stampings.

Rubber Phenolic Compound Provides High Shock Resistance

A new rubber phenolic molding powder which is said to provide high shock resistance characteristics in such products as instrument cases, knife handles and power tool handles which undergo rough treatment, has been developed by the *General Electric Co.'s Chemical Dept.*, Pittsfield, Mass. The new compound possesses the good moldability and heat resistance of wood-flour filled phenolics and is strengthened by the toughness and resiliency of Hycar-American rubber, a product of *B. F. Goodrich Chemical Co.*, Akron, Ohio, to the point where it can replace cotton flock and rag filled compounds for many applications.

Certain tests of the new compound, designated G-E 12446, indicate that its resistance to impact is many times more than that of standard wood-flour filled phenolic materials. It is reported to possess low bulk factor, powder pourability, provide good finish, and can be rapidly preformed in automatic equipment. The compound can be molded into complex parts by either compression or transfer methods in molds designed for ordinary wood-flour filled phenolics.

The inherent resiliency of the new material permits it to be molded around large complex inserts without cracking, and around inserts subject to flexing and vibration. Another feature reported is its excellent thermal shock resistance, which permits molded parts to be subjected to an instantaneous drop over a wide temperature range without cracking.

Temperature Control Designed for Aluminum Melting Furnaces

Batch furnaces for melting aluminum can be brought to temperature without overshooting by means of the duration-adjusting type of electric control, recently modified by *Leeds & Northrup Co.*, 4934 Stenton Ave., Philadelphia 44, for applications of this type. This equipment is said to prevent gas inclusions and blowholes, through limiting high-temperature swings which cause excessive formation of dross and absorption of gases.

With this control, furnaces can be brought to temperature at the maximum heating rate. To avoid overshoot, the controller automatically turns off the fuel supply at a predetermined point. If necessary, it also holds the charge at pouring temperature as long as desired. Instead of throttling the fuel valve, the device alternately turns the fuel from full on to full off. By controlling the durations of on-time, it supplies the heat input needed to balance the heat demand of the furnace, and thus holds temperature at the desired value.

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*

N-A-X HIGH-TENSILE stretches production per ton. Its greater strength and corrosion resistance make it possible to design sections an average of 25% lighter. That means one extra product for every three you are now building.

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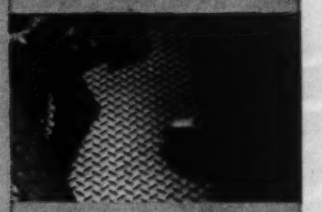

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EASY TO MATCH!

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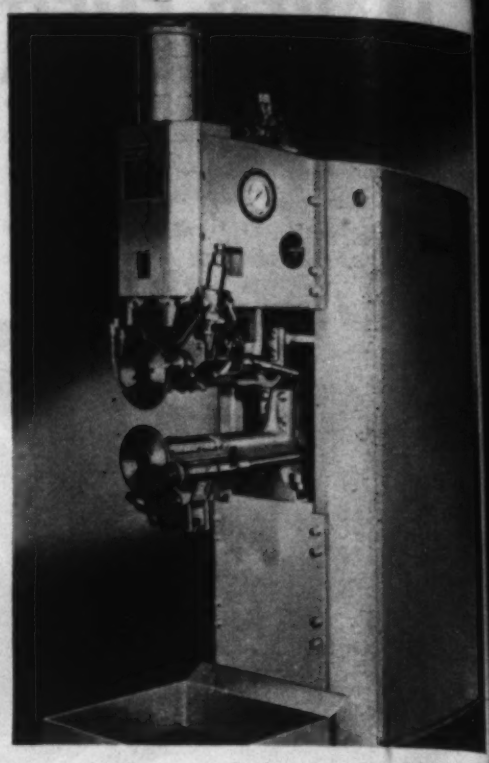
New Welding Products

Roller Head Seam Welders

A new line of roller-head seam welders has been announced by *Progressive Welder Co.*, 3050 E. Outer Drive, Detroit 12. The line comprises three basic sizes—light, medium and heavy duty. Each size is available in three types—for circular welding,



One of the new line of roller-head seam welders.

for longitudinal welding, or for both circular and longitudinal welding.

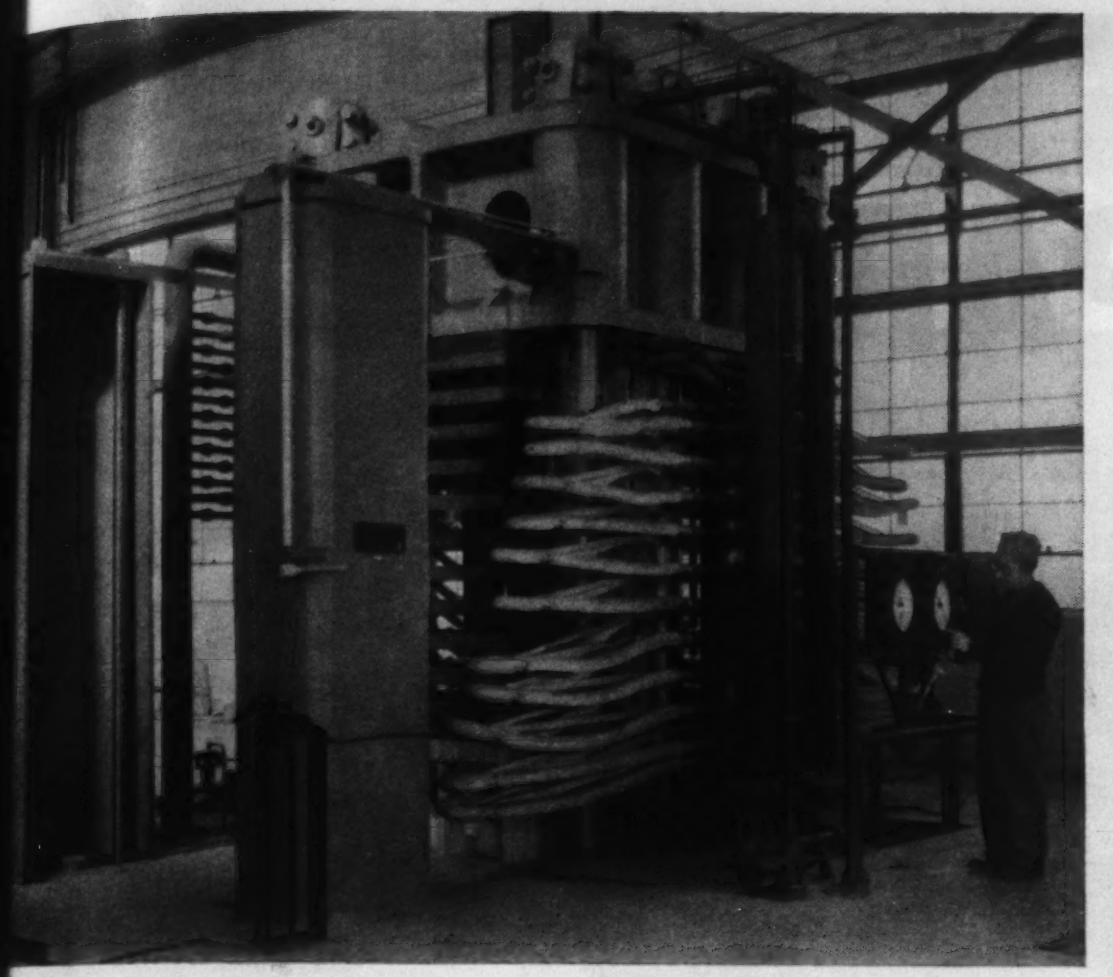
The seam welders may be used either for continuous, water or gas tight seam welding, or for roll-spot welding, and may be used for cold-rolled steel, stainless or other alloy steels, aluminum and other nonferrous alloys, as well as various types of coated metals.

Among the features of the new line is the use of a head guided and aligned by four sets of anti-friction rollers, so that the welding wheels will follow up and down even very small deviations in material thickness and contour. The rollers are matched in pairs, adjustable pre-loaded, and guide the head the full length of its vertical travel, riding on positive alignment V-guides on hardened and precision ground ways.

Other machine features include: ability to change over quickly from circular to longitudinal welding and back again; provision of larger throat clearance than usual to accommodate bulky work; transformer close coupled to the welding arms to reduce current loss; specially developed copper alloys to insure maximum strength where strength is needed; maximum conductivity where this is important; triple independent water cooling systems with visible outlets.

Bench Spot Welder

For joining small metal parts, *Weldex, Inc.*, Dept. K, 7370 McDonald Ave., Detroit, has introduced a new, fully automatic 7½-kva. bench-type spotwelder. The welder (Model 752-PB) is designed to handle light nonferrous metals of the same or dissimilar alloy and thickness, on a production basis, as well as ferrous metals up to



Want Your Press "JUST SO"?

If you do, it means a built-to-order job—the only way we ever build hydraulic presses. Specifications come from you; they are followed in every detail, so that the finished press is exactly as you want it.

For the plastics field, Bethlehem is equipped to turn out both hot-plate and molding types. These can be furnished with or without self-contained or separate hydraulic power systems. See us, too, for presses used in other kinds of work — metal forming, the making of fiber board, etc.

When it's a Bethlehem press, it's a product of good engineering all the way through—a job you can depend upon. Inquiries are invited.

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FOR PLASTICS • WALLBOARD
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AND OTHER APPLICATIONS

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"Brake Shoe Research serves you today, and anticipates tomorrow."
Wm. B. Given, Jr., President

CAST PARTS

. . . as made by BRAKE SHOE . . .

• If you need heavy cast parts made by the most modern methods to insure quality and efficiency, consider the 10,000 lb. diesel engine base shown above. For this casting Brake Shoe selected a type of Meehanite® providing ample strength and having the dampening capacity so necessary in such a casting to prevent the building up of excessive strains.

You can count on impartial, experienced recommendations from Brake Shoe metallurgists and foundry technical personnel. Whether ABK Metal, Gray Iron or Meehanite® is suggested, you can be sure the best for your purpose will be selected. Castings can be made in widely-used types (light, medium or heavy weight, green or dry sand or all core assemblies) including intricate or special types. Outline your cast parts requirements; let us tell you how we can fill them.

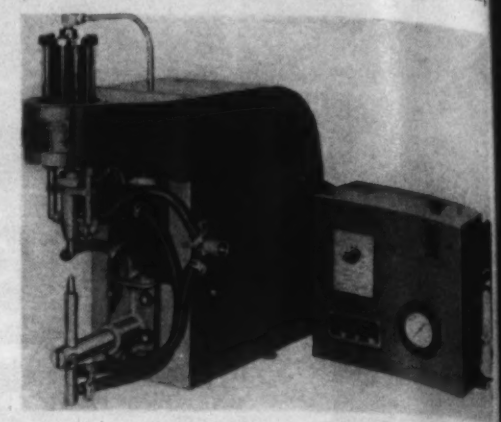
6713

Brake Shoe

BRAKE SHOE AND CASTINGS DIVISION
230 PARK AVENUE, NEW YORK 17, N. Y.

two thicknesses of 14-gage CRS or equivalent.

In addition to air strainer, regulator, gage and lubricator, standard equipment includes: a built-in four-step transformer tap changing switch; single acting air cylinder;



This bench-type spot welder is designed for joining small ferrous and nonferrous parts.

magnetic long-life contactor; and electronic timer. Regularly furnished for 220-v., 60-cycle, single-phase a.c. operation, this model is also available in 380 or 440 v. on special order. Standard throat depth is 4½ in. Complete with separate control cabinet, the unit occupies less than 2 sq. ft. of bench space.

Light Duty Projection Welder

A new projection welder for light jobs has been designed by *Acme Electric Welder Co.*, 2618 Fruitland Rd., Los Angeles, Calif. Designated as Type PT-O, the welder is an air operated, press type, direct action projection welding machine, supplied in either 20, 30 or 40 kva. Also, horn adapters and horns to convert for conventional spot welder use are available.

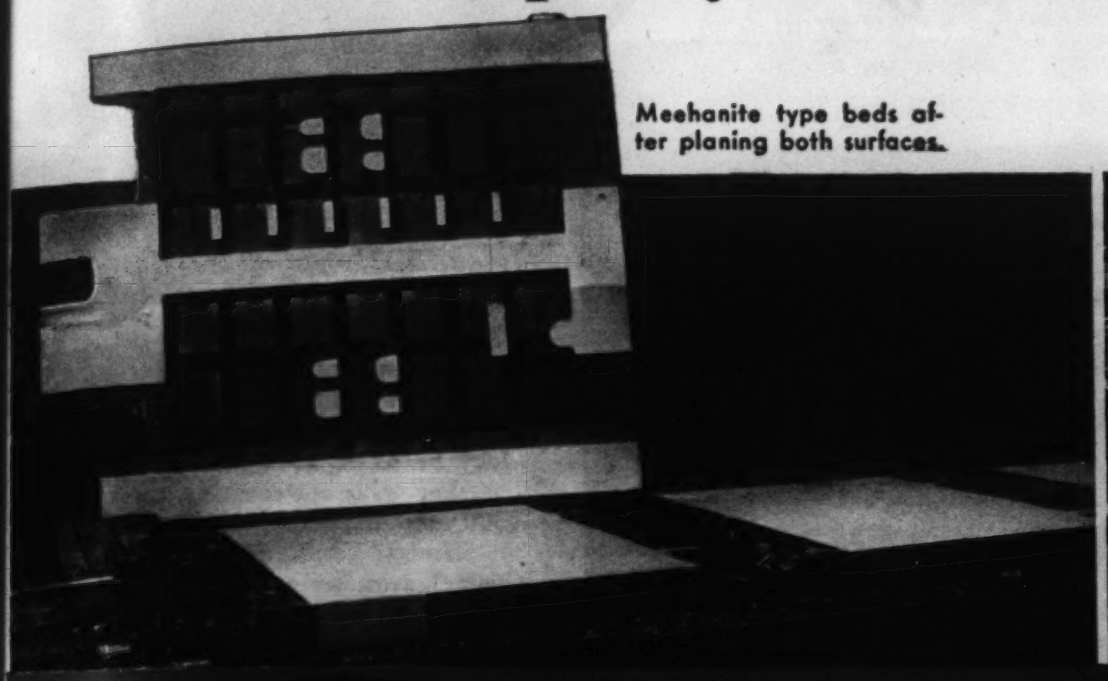
A solenoid operated air valve with either a single stage or a two-stage foot switch is furnished on the welder. Standard throat length is 6 in.; when converted to a spot welder, the machine's throat length is increased an additional 6 in. The welder is especially adapted to light work. One typical application is welding a stud in a stainless steel frying pan cover to which the cover handle is attached.

Resistance Welding Controls

Two new control units for resistance welding equipment have been recently announced by *Weltronic Co.*, 19482 W. Eight Mile Rd., Detroit 19. New built-in features have been incorporated in the latest model nonsynchronous control combination for foot-operated spot, projection and butt welders. Available in floor, side-of-welder or wall-mounting styles, the cabinet houses a NEMA 1A, 3B or 5B timer, fusible or nonfusible disconnect switch, line fuses, and an Ignitron contactor. The timer panel is designed to permit quick interchanging of 3B and 5B timers. Each time period is independently adjustable. Power supply unit is universal for all timers and operates on 208-, 230-, 380-, 460- or 575-v. power source.

The other control unit is a 3-phase multiple control combination. The remote control relay-timer incorporated in this model provides a variety of multiple welding sequences, weld No. 1, No. 2, No. 3, cascade, or simultaneous, with independent dial adjustment of weld time on each phase.

Builders of PRECISION Machinery Specify MEEHANITE® Castings



Meehanite type beds after planing both surfaces.

Printing type is set and locked up by the top surface of the Meehanite type bed. Any irregularity or imperfection in this bed would affect final printing quality.

Two typical Meehanite printing press gears.

MODERN printing presses are truly *precision* machines. To give added assurance of this quality to their equipment, the American Type Founders Corporation, Elizabeth, New Jersey, use a variety of Meehanite castings.

Of particular interest and genuinely important from the standpoint of smooth, dependable and precise operation are type beds and various gears. The beds require an extremely close-grained and flawless material, one which will maintain its dimensional accuracy and at the same time be freely machinable. Meehanite castings provide these qualities.

Meehanite printing press gears offer the required high vibration absorption capacity combined with adequate strength, toughness, machinability and uniformity.

Manufacturers of Meehanite castings utilize the scientific Meehanite production controls and processes which enable them to meet these and other rigid specifications of casting users whose objective is to produce quality products with maximum efficiency.

Write for our booklet entitled "The Role of Meehanite Metal Castings in Engineering Production."

See us at Booth 1610 at the Metal Show in Philadelphia.

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Builders Iron Foundry Inc.	Providence, R. I.
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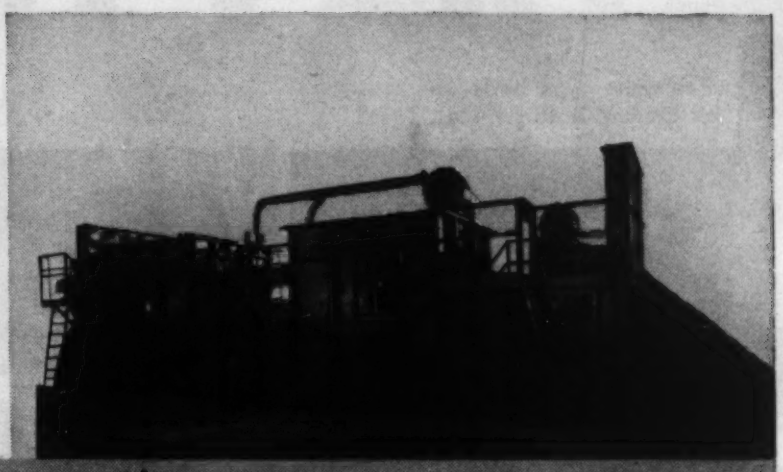
DEPENDABLE PRODUCT CONTROL

Automatically

MAXIMUM FLEXIBILITY of heating rate . . . soaking period . . . product travel . . . and size, shape and weight of product!

Step-by-step control through multi-zone construction with separate heaters, fans and controls for each zone.

Mechanized conveyor and fully automatic control throughout. Forced convection heating recirculated for maximum heating rate and uniformity. Gas or oil fuel.



HAGAN *automatic recirculating* DRAW FURNACE

AUTOMATIC MOVEMENT of product through Hardening Furnace—Automatic Quench—Draw Furnace!

HANDLES irregular sizes, shapes, weights simultaneously or in sequence . . . with uniform results.

For gas, oil or electricity. Requires only a two-man crew! Alloy carriers are not quenched.

HAGAN *continuous, automatic* HEAT TREATING FURNACE

HARDENS—DRAWS—STRESS-RELIEVES mixed products of variable sizes, weights and shapes with uniform results.

AUTOMATICALLY follows pre-determined heating, soaking, cooling cycle.

UNIFORM TEMPERATURE CONTROL lengthwise of furnace—accurately checked at up to 10 points in furnace.

SELF-CONTAINED car drive—Super-duty recirculating fans. Gas or oil fired.

HAGAN *automatic* CAR BOTTOM FURNACE

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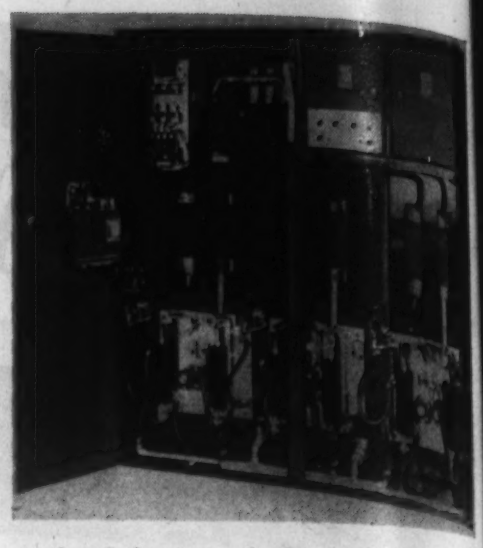


A detailed view of the multiple control combination unit for resistance welders.

Automatic control circuit protection is incorporated. Built-in disconnect switch or circuit breaker is available so that power may be wired directly to the unit. Circuit-breaker with interrupting capacity to 50,000 amp. may be supplied.

Standard equipment includes built-in water saver, with solenoid-operated water valve and water lines housed within the cabinet. A magnetic contactor for remote control, or motor starter is offered, and 1 to 3 kva. step-down transformer is available to supply auxiliary equipment.

Low Hydrogen Electrode

A new low-hydrogen type coated electrode designed to prevent underbead cracking in weld deposits has been announced by the *Air Reduction Sales Co.*, 60 E. 42 St., New York 17. The new electrode will be known as Airco No. 394. According to the manufacturer, this new electrode is one of the few of its type on the market today which operates on either a.c. or d.c., and is designed to give welds of 100,000 psi. It is anticipated that the electrode will find a market in the fabrication of hardenable steels that are susceptible to underbead cracking when conventional types of electrodes are used without preheat.

Four New Electrodes

Four new electrodes developed for use in a wide range of arc-welding operations have been announced by *General Electric Co.*, Schenectady 5. They are designated as Types W-60, W-61, W-62 and W-95. The Type W-60 is an electrode with a low-hydrogen coating, manganese-molybdenum analysis, good usability characteristics, and is suitable for welding most hardenable steels where the hazards of under-bead cracking are to be eliminated. The range of weldable materials includes low-alloy, high-sulfur, high-carbon, high manganese and similar high-hardenable and high-tensile steels.

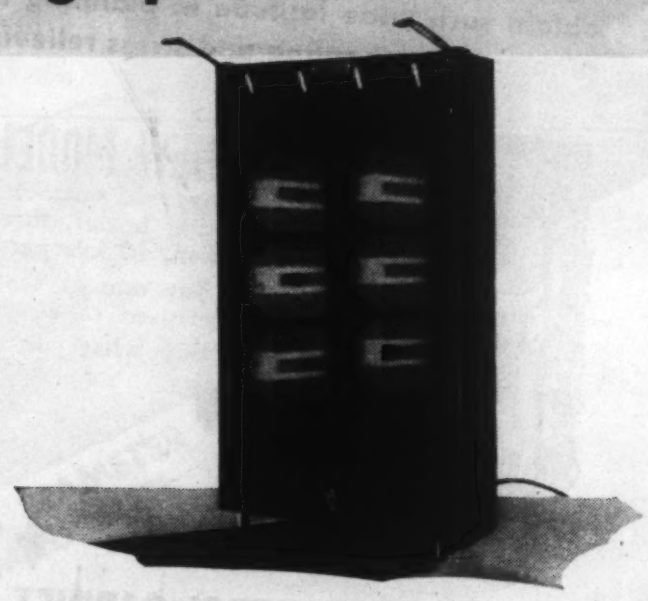
The Type W-61, a low-hydrogen electrode of molybdenum-vanadium composition, can be used with either a.c. or reverse polarity d.c. to weld a wide variety of low-alloy steels. A low-hydrogen, titania-coated electrode of 2½% nickel composition, the Type W-62 can be used on steel castings of a similar analysis and for producing weld deposits having high impact properties at sub-zero temperatures. Designed to deposit hard wear-resisting weld metal in all positions, using a.c. or d.c., the Type W-95

Maintaining casting soundness . . . run after run . . .

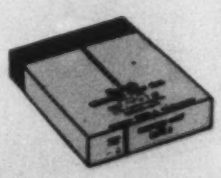
Many foundries have eliminated some of their most troublesome casting problems . . . have provided engineer and foundryman with more useful information . . . and have obtained more sound yield per melt . . . through radiography.

. . . assured by pilot and spot radiographic examination

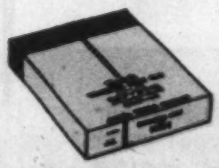
Radiography of the pilot castings helps get sound production runs going sooner . . . then radiographic spot testing of the runs keeps quality levels up to standard. Result: by increasing yield, radiography more than pays its own way.



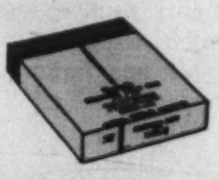
For maximum radiographic visibility . . . use Kodak Industrial X-ray Films



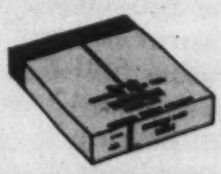
Kodak Industrial X-ray Film, TYPE A . . . for x-ray and gamma-ray work in sections where fine grain and high contrast are desirable for maximum sensitivity at moderate exposure times.



Kodak Industrial X-ray Film, TYPE K . . . designed for gamma-ray and x-ray radiography of heavy steel parts, and of lighter parts at limited voltages where high film speed is needed.



Kodak Industrial X-ray Film, TYPE M . . . first choice in critical inspection of light alloys, thin steel at moderate voltages, and heavy alloy parts with million-volt equipment.



Kodak Industrial X-ray Film, TYPE F . . . with calcium tungstate screens—primarily for radiography of heavy steel parts. For the fastest possible radiographic procedure.

They provide the high radiographic sensitivity—the combination of speed, contrast, and fine grain—required for the detail visibility you need in critical examination of castings.

For complete information on the types best adapted to your job, see your local x-ray dealer—or write to

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. . . another important function of photography

Kodak

A CINCH at 1800° F.

Preheating and Stress Relieving for Welding –by the Patented Smith-Dolan System

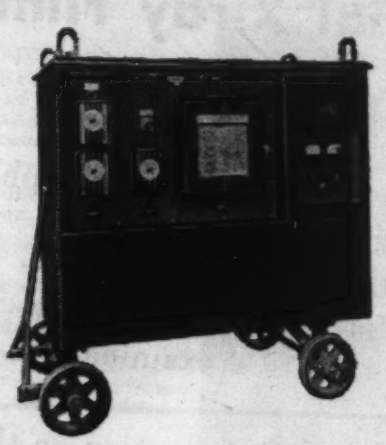
It's an accomplished fact that Electric Arc Induction Heaters, through the patented Smith-Dolan System, can generate heat to 1550° F and 1850° F on both chrome molybdenum and stainless steel. Here is equipment for ANY TYPE OF JOB—equipment that can be *purchased outright* or *rented*. From what other source could you possibly obtain such wide latitude in planning for every job, every problem in preheating and stress relieving before welding?

NEW MODEL U-P, Smith-Dolan System, portable, low frequency induction heater, three-high stack shown, 30 kva, 10 kva per unit.

Buy one or stack two or three for increased capacity.

Buy what you need—build as you go.

AUTOMATIC CONTROL CABINET
Used with Model U-P units (shown) and Model GC Duplex 120 or 150 kva induction heaters (shown in catalog).



MODEL BH, Smith-Dolan Induction Heater (mobile type) complete with self contained control instruments.

Electric Arc Induction Heating Equipment can be broken down to manual control, semi-automatic program control and fully automatic heat cycle program control. Operators find this equipment easy to use in field or shop, time saving and guaranteed to produce thorough penetration in heating large and heavy wall weldments. Today, more than ever, Electric Arc equipment is specified where other methods are too costly and impractical. Write for informative catalog.

ELECTRIC-ARC INC.

ELECTRIC-ARC, INC. 158 JELLIFF AVE. NEWARK 8, N. J.
WELDING EQUIPMENT, ELECTRODES & SUPPLIES

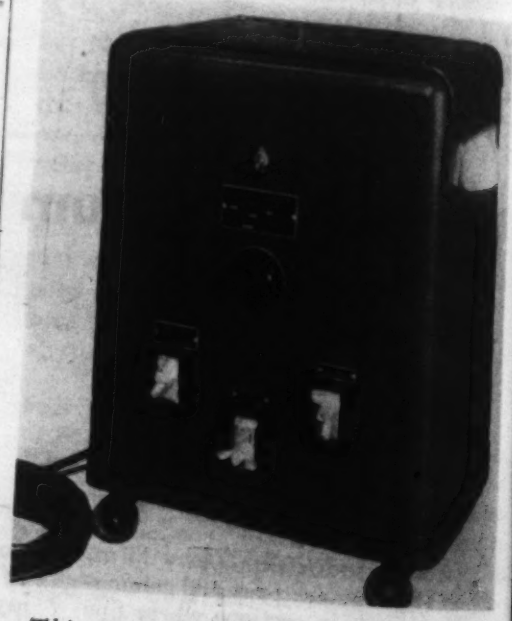
is suitable for surfacing dipper teeth, dra line bucket lifts, tractor cleats, roller crushe teeth, mud pumps, impeller crane hooks sand pumps, and sizing screens.

Welding Rod for Copper

A new torch welding rod, called Eutecrod 1805FC, for joining copper has been announced by *Eutectic Welding Alloys Corp.*, 40 Worth St., New York 13. It may be used with a torch adjusted for slight oxidizing flame, atomic hydrogen or twin carbon arc, where no oxyacetylene equipment is available. It has a tensile strength of 90,000 psi. and a Brinell hardness of 160 to 180, and is available in sizes ¼ in., 3/16 in., 3/32 in. and ⅛ in. flux coated, and in size 1/16 in. bare. It is designed particularly for oil refinery equipment, piping and fittings, roofing repair, copper tanks and tubing, copper valves and vats, copper kettles and heating apparatus.

High Frequency Stabilizer

A high frequency stabilizer, designed for use with ordinary a.c. or d.c. welders, is a new product of *Hobart Brothers Co.*, Troy, Ohio. It can be used in conjunction with inert-gas-shielded tungsten electrode welding, sheet metal work and other applications involving low currents, in vertical and overhead welding, and twin carbon arc torch welding. Especially developed to adapt ordinary a.c. transformer welders for inert-gas-shielded arc welding, this unit increases the impulses from 120 per sec. to 4,000,000 impulses per sec. An intensity control is provided so that the intensity of

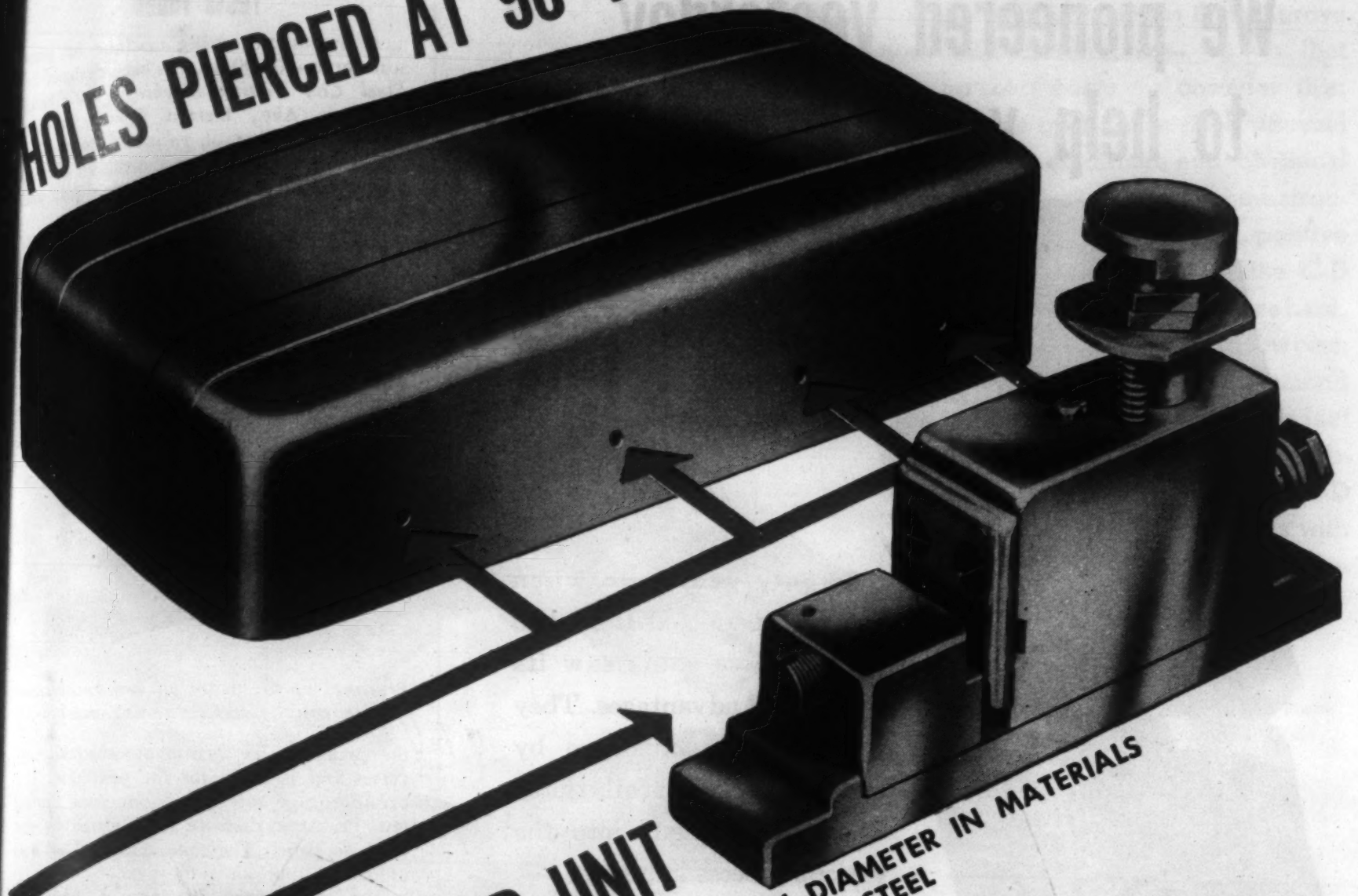


This frequency stabilizer can be used with both a.c. and d.c. welders.

the high frequency can be adjusted to suit the particular job at hand. It is available in two sizes with maximum capacities of 300 to 500 amp., respectively.

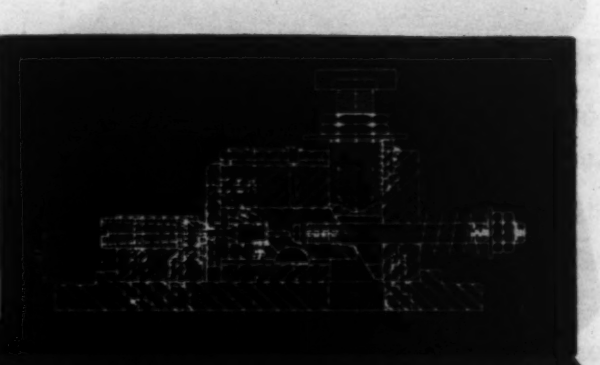
● Inserted tooth cutters said to embody new techniques in milling cutter design have been developed by the *Wendt-Sonis Co.*, Hannibal, Mo. Equipped with right-hand cutting blades as standard, the same cutter body can be used as a left-hand cutter by inserting a set of left-hand style blades. Blade holding fixture of the cutters is designed for quick and accurate blade setting.

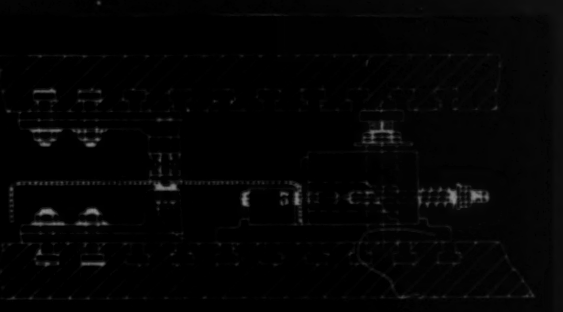
HOLES PIERCED AT 90° ANGLE...

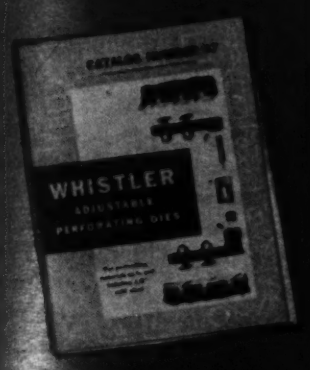


with NEW WHISTLER UNIT

PERFORATES HOLES UP TO ½" IN DIAMETER IN MATERIALS TO 1/16" THICK MILD STEEL







DETAILS EXPLAINED IN CATALOG NO. 47

Get the new 1948 catalog of this 90° perforating unit and other Whistler Adjustable Perforating Dies. Your copy of this catalog will be sent at once upon request.

Extruded shapes, ells, angles and other molded, shaped or fabricated pieces are easily pierced from the side at 90° with HU-50 Perforating Units. Quickly set up and adjustable, these units may be used separately or with standard perforating equipment. The advantages provided by other Whistler Adjustable Dies are retained. Absolute accuracy is assured. Quick change-over of hole arrangements can be made ... in many cases, on the press. Production economies and speeded up operating schedules are effected. Continued re-use of units in different groupings spreads initial cost.

It makes sense to look into the use of Whistler Adjustable Dies for all perforating, notching, slitting or rounding operations.

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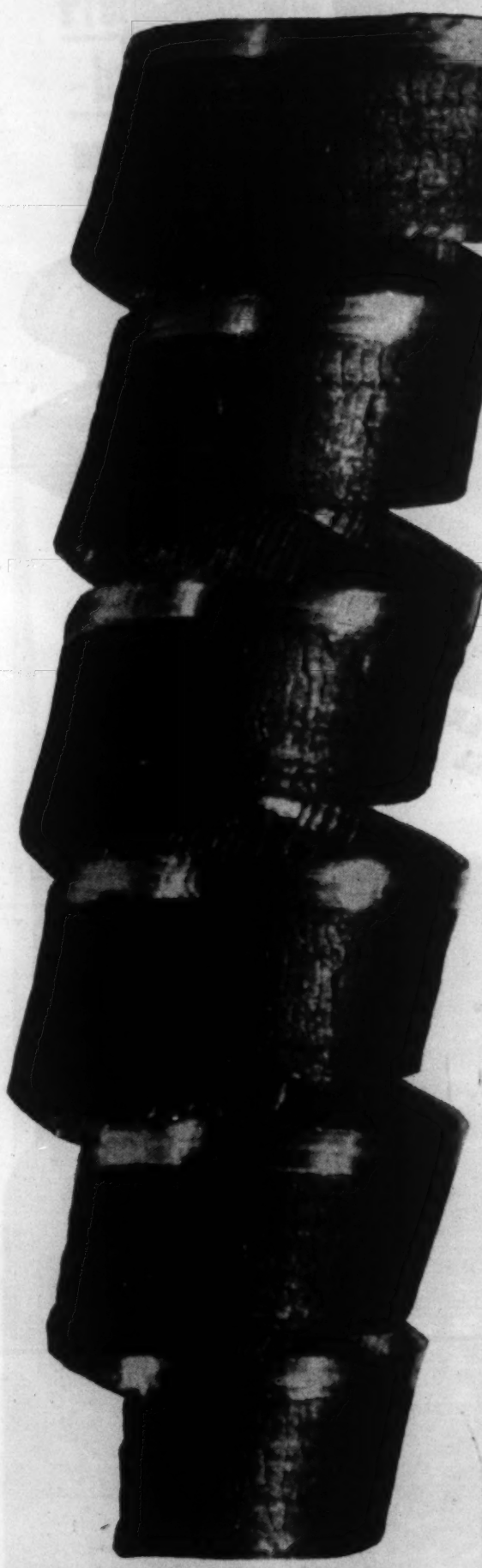


Greatly enlarged photograph of IngAclad machine cutting

ENGINEERING B-W PRODUCTION

Twenty years ago when Ingersoll perfected IngAclad, a few brave souls saw its economical advantages. They proved their confidence by ordering test installations. These went chiefly into the various process industries.

Today, IngAclad Stainless Clad Steel is accepted everywhere with the same confidence Ingersoll solid stainless steel is accepted.

Where budgets are tight—and where stainless service is required only for the contact side—specify IngAclad Stainless-Clad Steel. Available in sheets 18 to 8 gauge, and in plates 3/16" to 1/4" inclusive.

INGERSOLL Steel Division, Borg-Warner Corporation, 310 South Michigan Avenue, Chicago 4, Illinois.

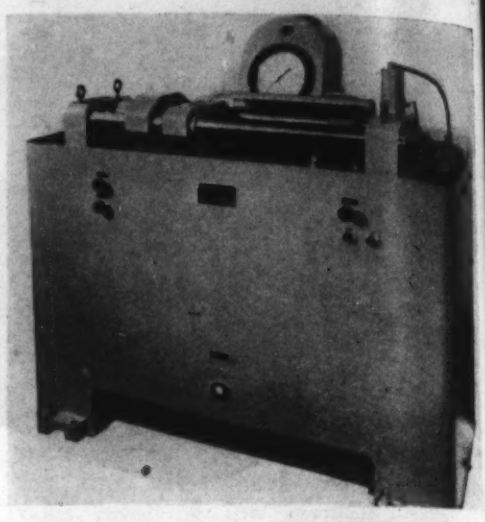
INGACLAD

STAINLESS-CLAD STEEL

Hydrostatic Machine Pressure Tests Tubes

A hydrostatic testing machine for pressures up to 20,000 psi. has been designed by *Steel City Testing Machines, Inc.*, 8843 Livernois Ave., Detroit 4, for pressure testing of tubing of various lengths. The machine seals the end of the tubing without any perceptible flare, eliminates air, and builds up to the required pressure.

For a predetermined time cycle it holds



Pressures up to 20,000 psi. can be obtained with this hydrostatic testing machine

the pressure and then it automatically reverses and is ready for the next test. The pressure gage can be disconnected during test. Peak test pressure is indicated by red light on panel. The time cycle of load and unload is approximately 4 sec.

The equipment consists of hydraulic pump and motor, electrical timers and switches, solenoids, relays and valves. It occupies floor area 15 sq. ft. and an overall height of 5 ft. This machine may be also built for higher pressures.

Band Saws for Light Metal Work

A new series of full size sawing machines has been introduced by the *DoAll Co.*, Des Plaines, Ill. The new machine is a 16-in. convertible model suitable for light manufacturers fabricating sheet metal products, plastic, cardboard or wood products.

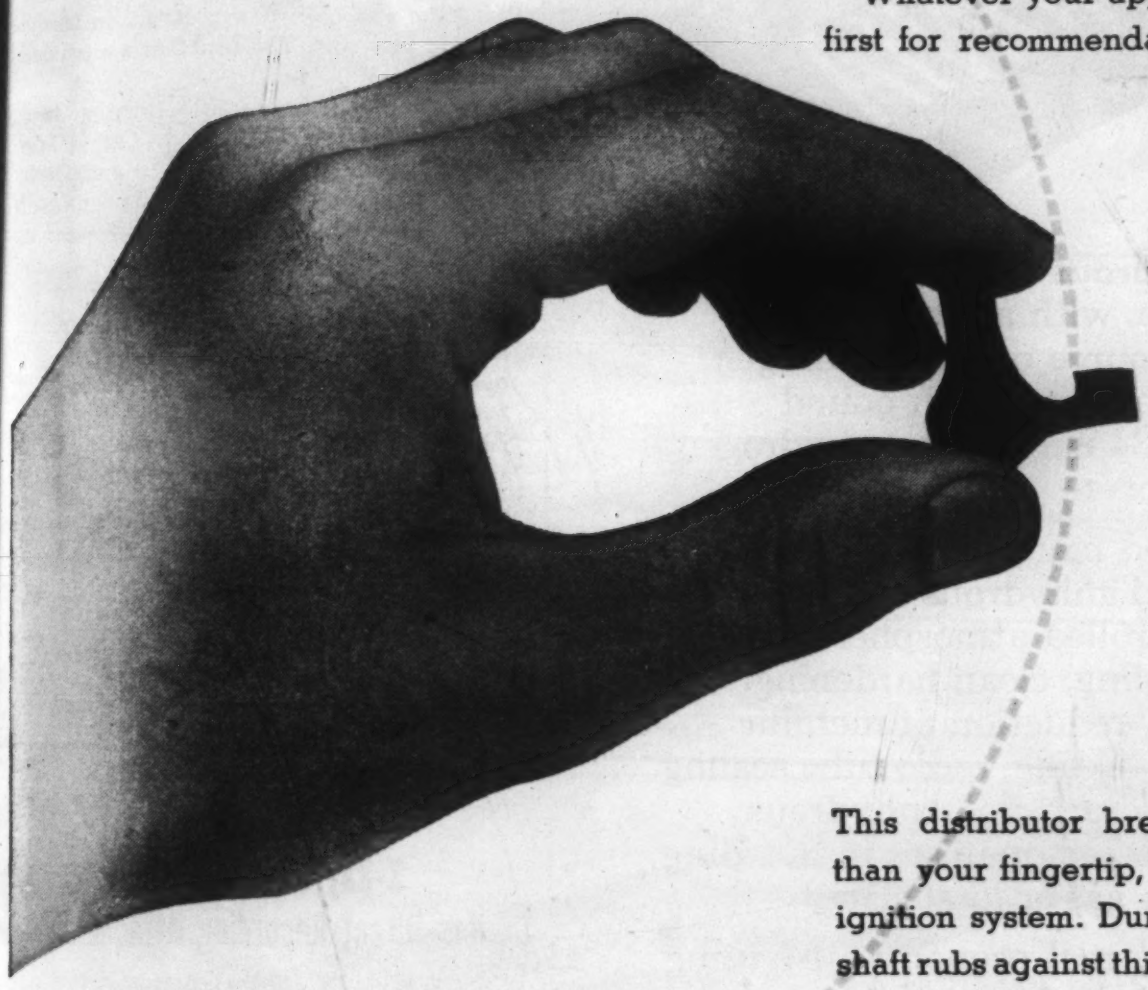
The shell of the saw is pressed steel, enclosing all working parts. The frame is arc-welded over die forms and is integral with shell structure. Motor and drive mechanism is isolated by a steel baffle plate. Throat depth is 16 in., work thickness capacity 12⅛ in., table size 20 by 20 in. with 45-deg. tilt right and 5-deg. left.

Drive wheels are cast aluminum, Neoprene tired, and roll on ball bearings. Access doors, both front and back, swing open and snap shut. Saw blade tension indicator is calibrated for different saw widths. Job selector dials on variable speed machines correlate sawing factors to show best sawing operations for each type and thickness of material being sawed.

How to Increase Product Acceptance ...through New Product Advantages

One of the surest ways to increase acceptance for any product . . . is to add advantages that improve quality, appearance, and performance. To do that . . . *without increasing unit costs* . . . consider this: Continental-Diamond Plastics give you a new, unusual *combination* of mechanical, electrical and chemical properties. Among other advantages, they combine structural strength, light weight, electrical insulation, positive resistance to moisture, heat and corrosion. Like C-D *Dilecto* used in the application shown here, they are hard, dense, long-wearing . . . are quickly machined, at low cost.

Whatever your application, see Continental-Diamond first for recommendations that lead to higher product quality and acceptance, lower fabricating costs. Your nearest C-D office has trained technicians with additional information that will interest you. Call or write, now.



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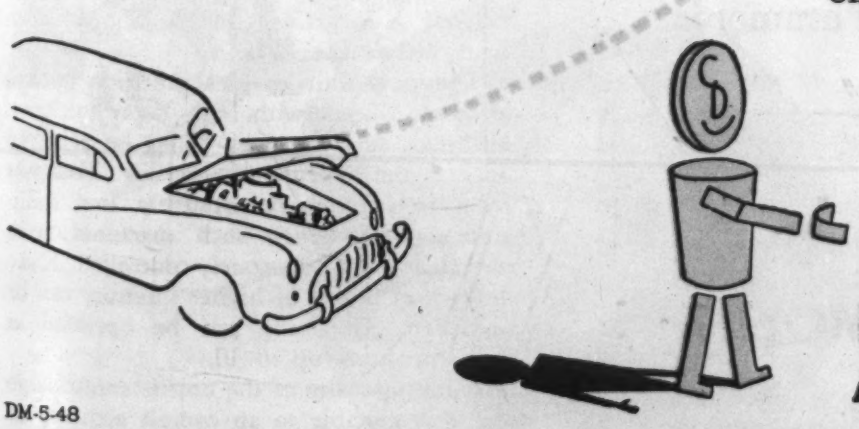
VULCOID—Resin Impregnated Fibre
DILECTO—Laminated Thermosetting Plastic
CELORON—Molded High-Strength Plastic
MICABOND—Bonded Mica Splittings

Another C-D Case of Top Performance

This distributor breaker arm blank, not much larger than your fingertip, is an integral part of an automotive ignition system. During 10,000 miles of driving, a cam shaft rubs against this C-D *Dilecto* block over *12 million* times! In this application, as in a host of others, a C-D Plastic is proving its ability to provide dependable mechanical service—plus positive electrical insulation.



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Barrett Standard Anhydrous Ammonia, 99.95% NH_3, oxygen free, with a very low dew point, is an economical source of pure hydrogen and nitrogen. When dissociated, each pound produces approximately 34 cubic feet of hydrogen and 11 cubic feet of nitrogen.

Engineers have discovered many advantages from the use of dissociated anhydrous ammonia in the production of controlled atmospheres in furnaces for bright annealing, clean hardening, copper brazing, sintering, reduction of metallic oxides, atomic hydrogen welding, radio tube sealing and other metal-treating practices. Anhydrous ammonia also has unsurpassed qualities in nitriding of steel, used as ammonia gas or dissociated.

Metallurgists are effecting real economies by using Barrett Standard Anhydrous Ammonia as a replacement for other more expensive sources of hydrogen and nitrogen. For information, contact Barrett, America's leading distributor of ammonia.

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40 RECTOR STREET, NEW YORK 6, N. Y.

High Frequency Heater for Brazing and Heat Treating

Controlled brazing, soldering and heat treating of metals are the major applications of a new high frequency heater announced by *Radio Frequency Corp.*, Boston 34, Mass. In operation this unit produces a magnetic field oscillating about one-half million times a sec. Metals subjected to the field are heated in a matter of seconds. Heat input is controlled to provide the right amount of heat to braze or solder parts in production set-ups.

The new heater, called Model 3000-B, incorporates new circuit design. Features are small size and completely automatic operation with no knobs to turn or adjustments to make and high power output in relation to size and cost. The unit has a maximum output of 3000 w.

With this machine such items as snaps and catches can be brazed. Carbide tips up to ¾ in. can likewise be brazed. By electronically preheating, brushes and tools can be inserted into plastic handles and no glue is required. Likewise, such handles can be readily removed as the shank of the brush can be heated while inside the plastic handle without heating the plastic. By preheating the shank and using resin glues, wooden handles can be set quickly. Small parts can be case hardened with this unit and soft soldering operations can often be done in less than a second.

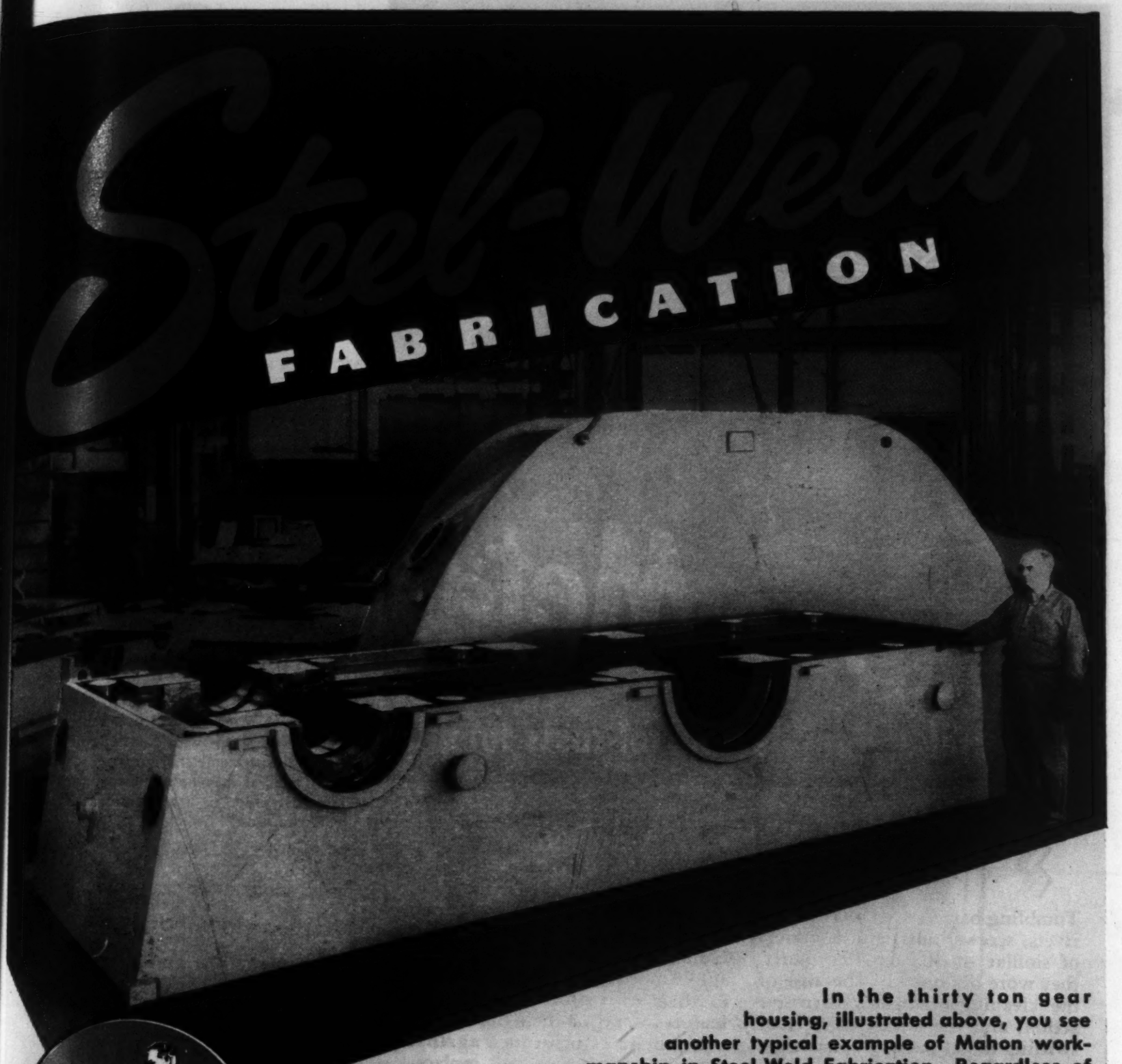
X-Ray Diffraction Unit Has Direct Recording Attachment

New fields of application for X-ray diffraction in the identification and quantitative analysis of unknown materials are reported to be opened by a new X-ray diffraction machine developed by *General Electric X-Ray Corp.*, 4855 W. McGeoch Ave., Milwaukee, Wis.

The new unit couples precision control of X-ray output with high X-ray intensity. Hitherto, such accuracy could be achieved only at the expense of intensity. This was reflected in the comparatively low milliamperage at which such machines were operated. Now, accurately-controlled X-ray diffraction beams of higher intensity can be produced. The tube can be operated at milliamperages up to 30.

X-ray intensity of the unit is controllable and reproducible to an overall accuracy of 0.5%. The accuracy is accomplished by controlling the X-ray tube voltage to within 0.1% and the tube current to within 0.02%. Because higher intensity makes it possible to direct a comparatively narrow beam of X-radiation from a very narrow source to the specimen under observation, both the resolution of spectral lines and the speed of analysis are greatly increased.

The new instrument may be used, with



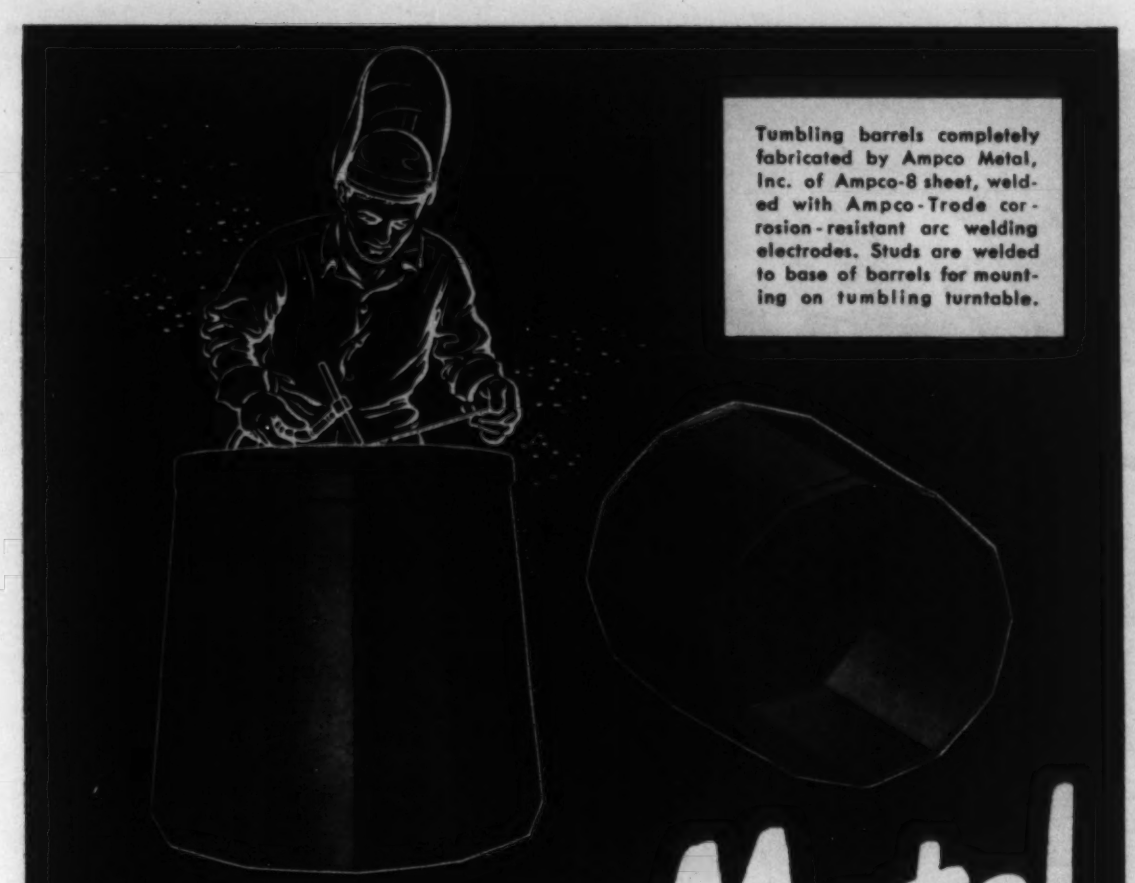
In the thirty ton gear housing, illustrated above, you see another typical example of Mahon workmanship in Steel-Weld Fabrication. Regardless of what your requirements might be—regardless of size, shape or weight, you will find in the Mahon organization a source for tailor-made weldments which offers every modern facility for economical production, processing, and complete machining. These modern facilities in the hands of highly skilled craftsmen, plus a staff of design engineering experts, is your assurance of a better, smoother appearing job, embodying every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY

Detroit 11, Michigan

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON



Tumbling barrels completely fabricated by Ampco Metal, Inc. of Ampco-8 sheet, welded with Ampco-Trode corrosion-resistant arc welding electrodes. Studs are welded to base of barrels for mounting on tumbling turntable.

Ampco Metal

makes tumbler-barrel costs tumble

Using Ampco rolled sheet cuts maintenance and replacements

Tumbling barrels are used to clean rivets, screws, nuts, and a variety of similar small parts. Formerly, they wore out quickly—because of the cleaning solution's corrosive action, and the abrasive effect of swirling metal parts. Replacement costs were high, until the manufacturers switched to tumbling barrels fabricated with Ampco-8 sheet. This durable, corrosion-resistant alloy solved their expensive replacement problem in jig-time.

That is just one more case of the money-saving value of Ampco Metal's unique physical properties. Hundreds of companies use durable Ampco Metal and Ampcoloys in their own products as selling features—and in their production equipment as insurance against heavy maintenance and replacement costs on parts subject to wear.

Call in your nearby Ampco engineer for cost-cutting suggestions. Write for complete information on Ampco castings, extrusions, forgings, sheet, and fabricating service.

Ampco Metal, Inc.

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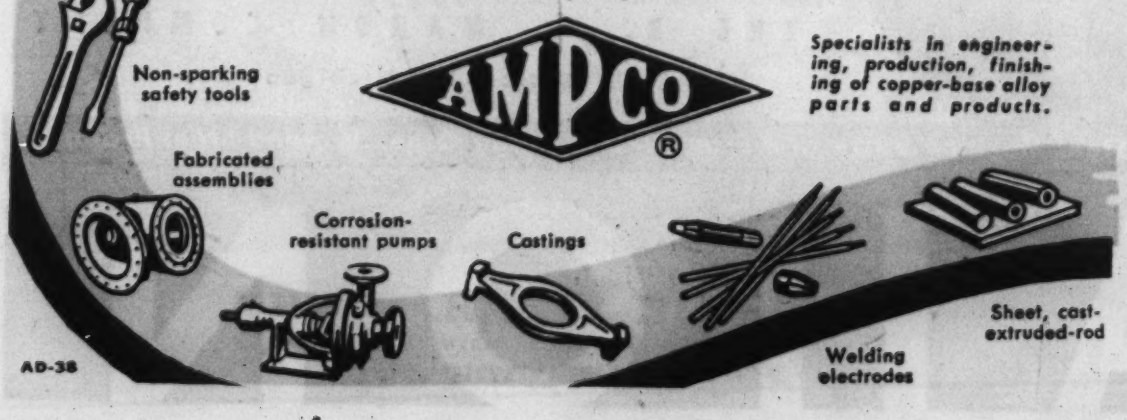
Field offices in principal cities



different attachments, for three different purposes. One of these is for the direct measurement of X-ray diffraction intensities through the use of a Geiger-Mueller counter in combination with a rate meter, scaler and chart recorder. The counter is capable of counting diffracted X-ray quanta linearly over a longer range of intensities than before possible. The rate meter, which is matched with the strip chart recorder, has a logarithmic response over three decades.

The second manner in which the unit may be used is as a fluorescent X-ray spectrometer, employing a focusing crystal analyzer. This extends the range of composition of materials which can be analyzed, in comparison with that possible using optical spectrometers.

When used with a fluorescent analyzer, this X-ray diffraction unit extends range of compositions of materials which can be analyzed.

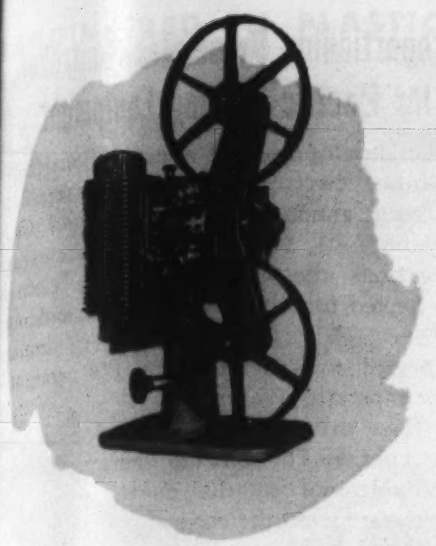
Third, it may be employed, with X-ray-sensitive film, as a conventional X-ray diffraction unit.

Sintered Carbide Alloy Developed for Planer Tools

Development of a sintered carbide alloy, especially designed for high-speed planer tools, has been announced by the *Carbide Alloys Div., Allegheny Ludlum Steel Corp.*, Pittsburgh 22. The new alloy, which was developed with the cooperation of manufacturers of high-speed planers, is called Carmet Grade CA-51, and the blanks can be supplied for planers using either the "clamped in" or brazed type blanks.

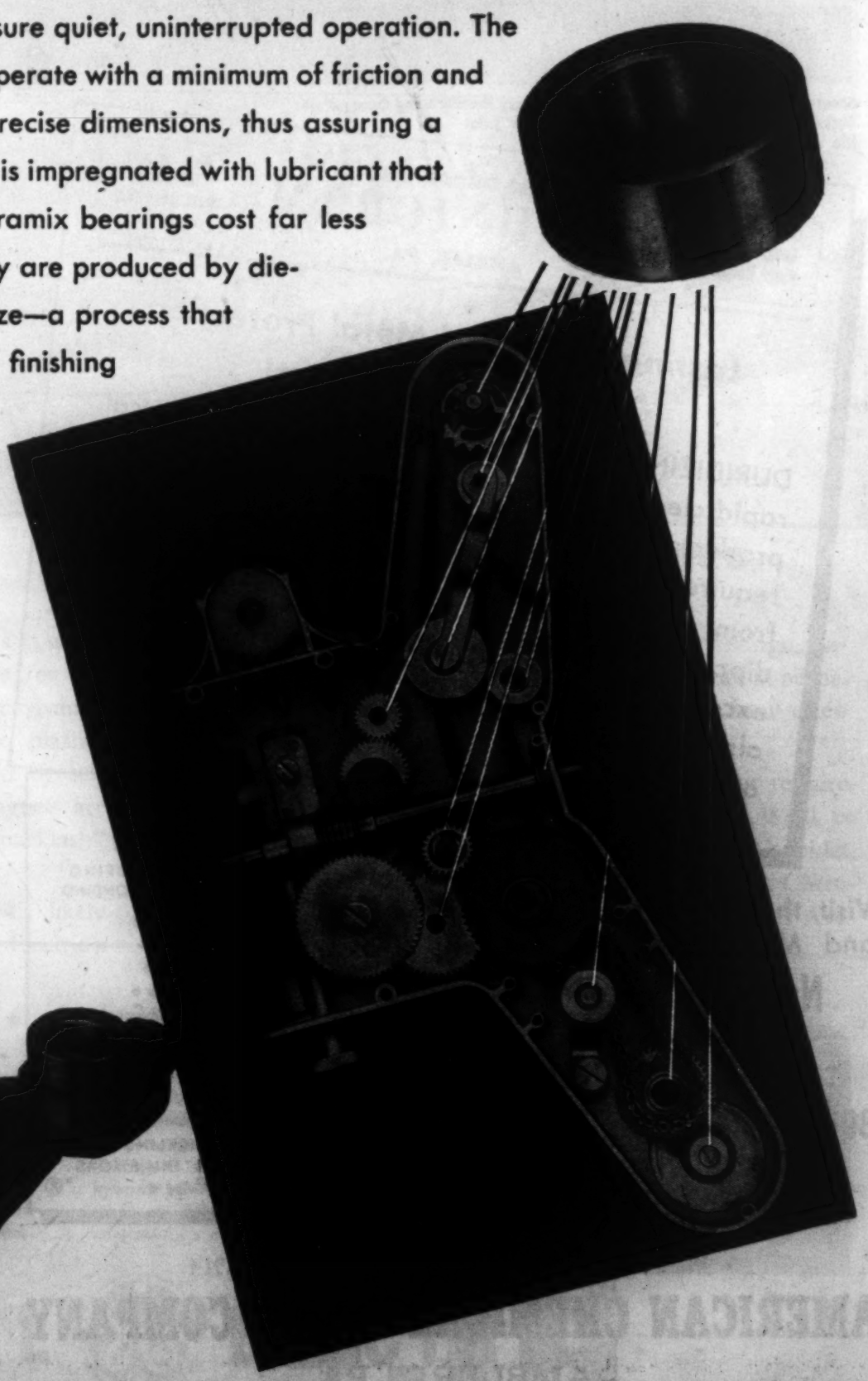
A series of tests have been run with a planer using "clamped in" blanks. In a typical test a 60% semi-steel casting was cut. Depth of cut was up to 1½ in.; the feed was 0.10 in. and surface speed 175 ft. per min. As much as 2100 lb. of metal were removed per grind of tool. The most economical metal removed was 1750 lb. per grind.

Other applications for this alloy include blanks for heavy turning, boring and facing tools, as well as similar operations where an exceptional strong carbide is required.



Gramix bearings reduce noise and wear to an absolute minimum in Revere 8 mm. film projector

If you're looking for a way to make your mechanical products operate more quietly and dependably — and at the same time decrease your production costs — you may find the answer in Gramix metal powder parts. The Revere Camera Company of Chicago did. This firm is equipping its latest type motion picture projector with Gramix bearings to insure quiet, uninterrupted operation. The eleven tough little Gramix bearings operate with a minimum of friction and noise because 1) they are made to precise dimensions, thus assuring a close fit, and 2) their porous structure is impregnated with lubricant that will last the life of the projector. Gramix bearings cost far less than machined bearings because they are produced by die-pressing powdered metal to exact size—a process that eliminates expensive machining and finishing operations. Gramix bearings have perfect bearing surfaces. They can be manufactured to almost any size, shape or dimension. Send us sketches or prints of your products. Our engineers will show you where Gramix bearings, washers, seals, gears, or other parts will improve mechanical performance and save you money.



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Sheet steel kitchen cabinet assemblies at Tracy Manufacturing Company are Duridized in this power spray washer for long paint life and overall product protection.

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Proportioning Pyrometer Controller for Electric Heating Equipment

The development of a proportional current-input electronic pyrometer controller has been announced by the *Bristol Co.*, Waterbury 91, Conn. The new instrument proportions the current input to electrically-heated furnaces, ovens, plastic molding machines, salt pots, and other similar equipment to provide practically straight-line temperature control.

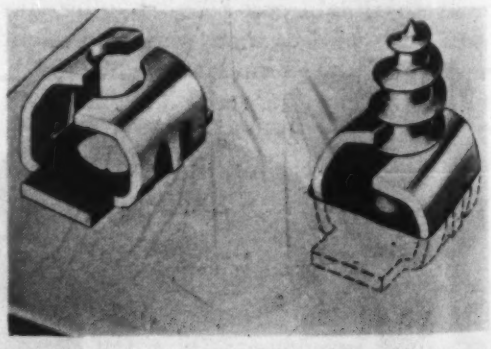
It does this by time modulation of the input energy. The average energy supplied is proportional to the deviation of the temperature from the control point throughout a band width, which is adjustable from 0 to 2½% of full scale reading.

Fastener for Sheet Metal Assemblies

A new spring steel fastener for assembling sheet metal products has been introduced by *Prestole Corp.*, 3139 Bellevue Road, Toledo 6, Ohio. The nut is simply pressed into assembly position. It is attached directly from the work surface, instead of reverse side of panel. It snaps into a 9/32-in. square hole in panels 0.037 in. to 0.055 in. thick, and is designed for easy entrance of screw, even in cases of misalignment of panels.

As the screw is driven, the arched spring arms of the nut expand just enough to permit entry of the screw, locking the fastener to the inner panel, and at the same time binding against the root of the screw thread. This new fastener will accommodate both No. 8 and No. 10 sheet metal screws, the larger size merely expanding the spring arms further apart. It will withstand a tightening torque of 35 to 45 in. lb.

Other features of the fastener, called Snap Nut, are fastening elasticity created



Close-up view of new fasteners showing how they lock onto the sheet metal screws.

by forming and heat treating, easy removal when necessary, and protection against dead-tight fastening, which causes chipping and crazing of enamel. The nut is particularly suited for blind attachments on automobiles, radios, refrigerators, stoves, heaters, and other mass production products.

ENGINEERED IN PLASTICS BY GENERAL ELECTRIC

Plastics Land the Big Ones

● Plastics go fishing! Major parts for the Inductor salt water surf casting reel are molded by General Electric for the Ocean City Manufacturing Co., Philadelphia, Pennsylvania. For this job, G-E formulated a tough, durable plastics material of high impact strength. It is unaffected by salt water. And General Electric alnico permanent magnets are built into this reel to form a new, magnetic "anti-backlash" brake.

You may not manufacture fishing reels, but it's likely that plastics have a place in *your* business. General Electric's *complete* plastics service can work for you—to design, engineer, and mold plastics parts to meet your individual needs. Take advantage of this unique service—discover how often it can lower your costs, improve your products.

Write us for more information, outlining your requirements. Or contact your nearest G-E sales office. We'll be glad to send you, free, the interesting, informative booklet, "Design Data on Plastics." Address: Plastics Division, Chemical Department, General Electric Company, 1 Plastics Avenue, Pittsfield, Massachusetts.

G-E COMPLETE SERVICE—AT NO. 1 PLASTICS AVENUE

Backed by 54 years of experience. We've been designing and manufacturing plastics products since 1894. General Electric research facilities have expanded continually, working to develop new materials, new processes, new applications for plastics parts.

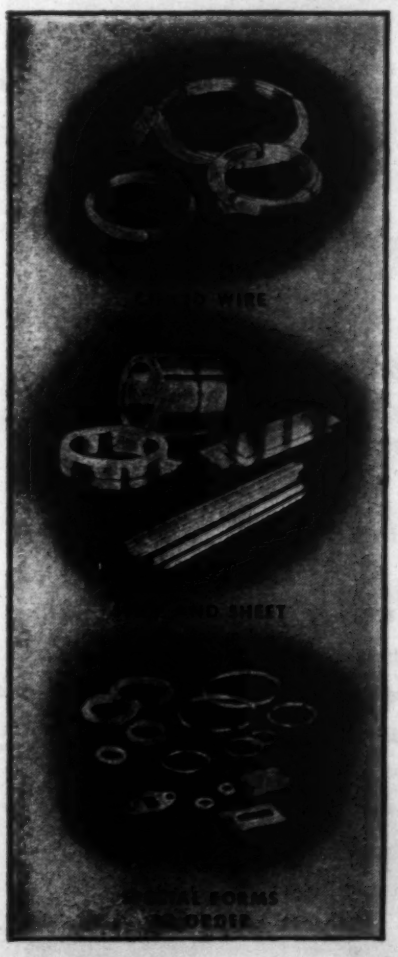
No. 1 Plastics Avenue—complete plastics service—engineering, design, mold-making. G-E industrial designers work with our engineers to create plastics parts, sound and good looking. Skilled mold-makers in G-E toolrooms average over 13 years experience.

All types of plastics. Compression, injection, transfer and cold mold facilities . . . high and low pressure laminating . . . fabricating. G-E Quality Control—a byword in industry, means as many as 160 inspections and analyses for a single plastics part.

GENERAL ELECTRIC

CD48-A38

General Electric plastics factories are located in Scranton, Pa., Meriden, Conn., Coshocton, Ohio, Decatur, Ill., Taunton and Pittsfield, Mass.



Here's the low temperature silver brazing alloy for real production. With exceptional fast flowing properties at low temperature (liquidus 1195°F) it penetrates deeply and makes strong, leak-tight joints on both ferrous and non-ferrous metals. Economical too — only 45% silver.

APW 217 is the PREFERRED brazing alloy for tough production jobs throughout the refrigeration, air conditioning, automotive and appliance industries. If you haven't tried APW 217, write today for our descriptive folder #45 and let us have your requirements.

We'll be glad to quote without obligation on any quantity, any size, wire, sheet, strip, rings or washers.

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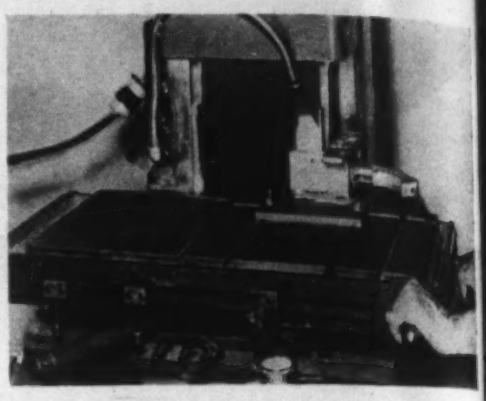
Precision Table for Belt Grinder Redesigned

An improved automatic feed table, the Model FT-9, is now available from *Porter-Cable Machine Co.*, Syracuse, N. Y., for the Model BG-8 wet abrasive belt grinder. The redesigned table is said to provide greater precision and a smoother approach for feeding work into the grit belt.

Any material may be ground and polished to a close tolerance—plastics, glass, ceramics, wood, etc. The machine chamfers, rounds,



The new model feed table with a work piece attached is shown here.

squares, forms radii, and grinds flat and parallel surfaces.

Earlier models of this table used the same oil-coolant in the recirculating system as a hydraulic liquid for the feed table. Two separate systems have now been installed. Special coolants may be used for various materials, while the table is independently operated by a standard hydraulic oil. In addition, a rod has been added to the former free piston, with a gland at the end of the cylinder oil shield, to assure smooth positive action at all times.

The table automatically controls the pressure and rate of feed while a dial indicator shows rate of machining. A micrometer stop halts the operation, and can be reset instantly. Additional manual controls permit a wide variety of applications.

Electric Furnaces Feature Heavy Heating Elements

New bench-type electric furnaces for laboratory uses and heat treating of carbon and high chromium steel parts and tools are being produced by *Thermo Electric Manufacturing Co.*, Dubuque, Iowa. The new models are designated as Series 1500, 1600 and 1700. There are six sizes ranging in chamber dimensions from 4 in. wide, 3½ in. high and 4½ in. deep to 8½ in. wide, 7½ in. high and 18 in. deep.

The furnaces may be operated up to 1650 F for continuous use and to 1900 F for short periods. Heavy gage nickel-chromium heating elements used in these new furnaces are said to have a very low ratio of watts per sq. in. of heating surface. The elements are embedded in refractory plates which form the sides, top and bottom of the

3 ways photography shows the behavior of materials under stress

1. Photographic trace recording to study the behavior of materials under dynamic stress conditions . . . Using bonded wire strain gages coupled to oscillographs, this technic makes it possible to record and measure changes in stress during rapidly applied loadings. This trace recording shows strains at three points along a shouldered bar under longitudinal impact.

2. Photoelastic stress analysis to study the behavior of materials under static or dynamic stress conditions . . . Using polarized light sent through plastic models of the part under test, this technic enables the design engineer to evaluate stress concentration factors and obtain a precise knowledge of actual peak stresses prevailing. This photoelastic stress pattern shows regions of high stress in meshing gears.

3. Photo-grids to study the behavior of materials under tensile stress conditions . . . Using the Kodak Transfax Process, involving a Kodak light-sensitive material, as many as 200 accurately spaced lines per inch may be photoprinted on the material itself. After deformation, measurement of these lines will reveal distribution of plastic flow. This photograph shows photo-grids on a flat tensile specimen after elongation.

Whatever you do with photography, there's a Kodak material for the job. For trace recording, Kodak Linagraph Papers and Films come in 8,618 different combinations of specifications. For photoelastic stress analysis, you use Kodak Super Panchro-Press Plates when light levels are low or Kodak Process Panchromatic Plates when you're after high contrast and extreme resolution. And if you want to put a detailed, tight-clinging pattern on metal, you do it with Kodak Transfax.

To answer your questions on selection and handling of all Kodak materials, feel free to write us.

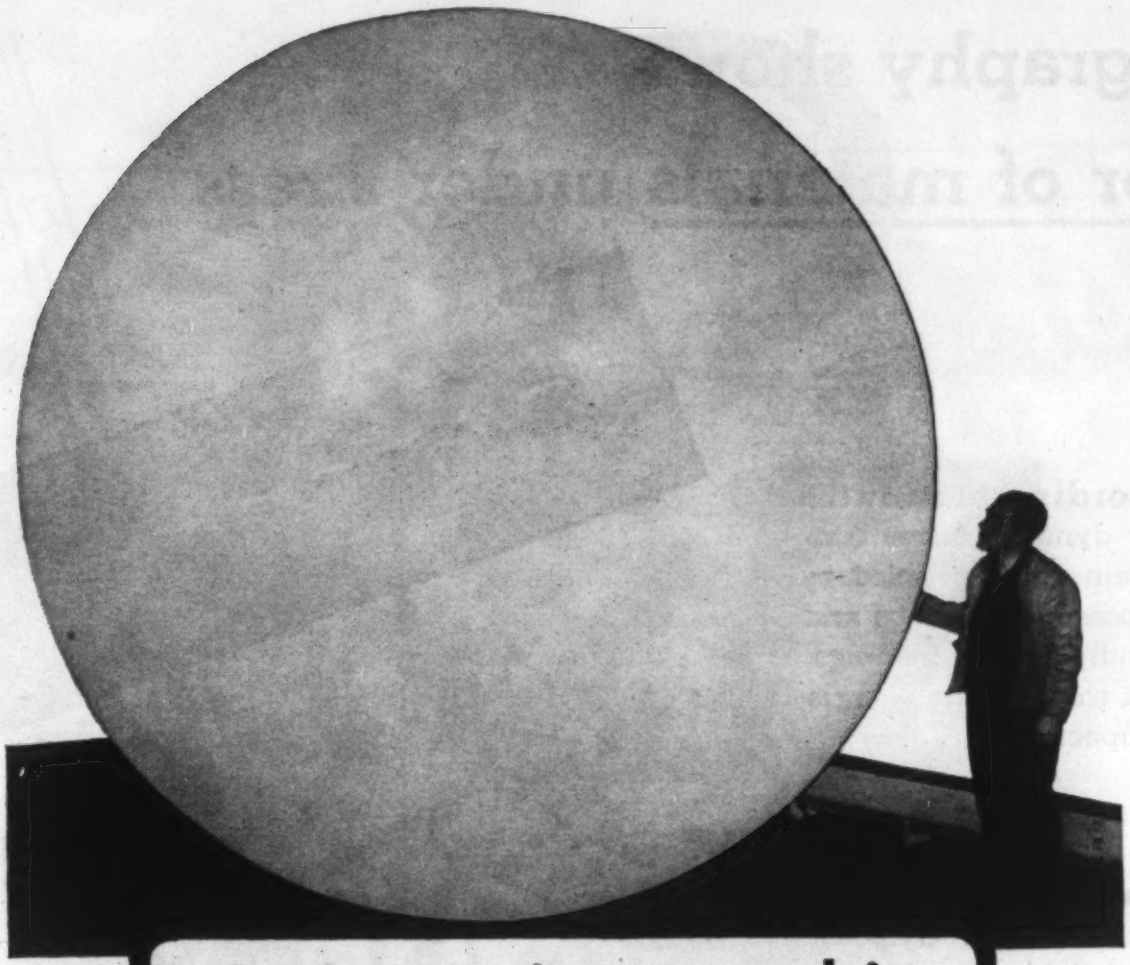
Eastman Kodak Company, Rochester 4, N. Y.

"Kodak" is a trade-mark

FUNCTIONAL PHOTOGRAPHY

. . . is advancing industrial technics

Kodak



Are you going around in

STAINLESS CIRCLES?

Cutting Stainless Steel to shape is easy—when you have the proper equipment.

G. O. Carlson, Inc. regularly supplies diameters from our own plate in sizes ranging from less than one inch to the world's largest —to your precise specifications, in any thickness.

You usually save money and time by ordering diameters, circles, rings, and heads from G. O. Carlson, Inc. Highly specialized cutting facilities for Stainless Steel have been developed at our plant to handle a wide range of requirements. Why not take advantage of our equipment?

Send us your next order for stainless steel diameters—produced from plate to chemical industry standards, cut to your order ready to use.

G. O. CARLSON, INC.

Stainless Steels Exclusively

200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

Warehouse distributors in principal cities

heating chamber. The manufacturer ports that this construction protects from physical damage, minimizes oxid and provides the most even distributio heat. Element plates are easily rep without dismantling the furnace. Side p are interchangeable, as are also the top bottom plates.

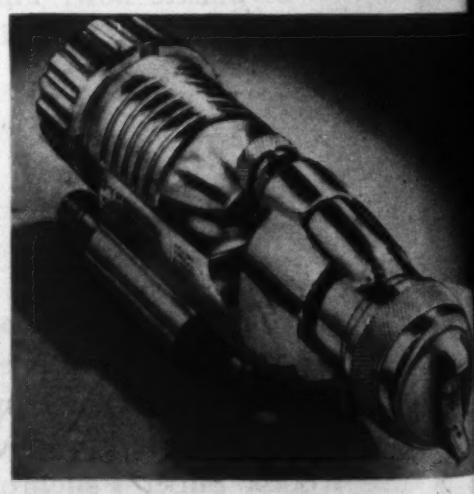
All models have uplifting counte anced doors except the two largest size which the door is divided horizontally two sections, permitting the bottom ha be lowered separately and allowing a to the chamber with minimum loss of Furnace bodies are of welded steel cons tion with dual insulation 3 in. thick in smaller sizes to 6 in. thick in the la units.

The two smaller-size furnaces have indicating pyrometer, pilot light, to switch, and stepless input controller insta in an instrument panel in the base of furnace. Four sizes are available for op tion on either 115 or 230 v., 50/60 cy The two larger sizes are for 230 v. only

Automatic Spray Gun Has Fast Acti

A new spray gun has been developed the *DeVilbiss Co.*, 300 Phillips Ave., Tol 1, Ohio, which is claimed to meet needs for a faster acting automatic sp gun that has greater capacity and simp controls. It is built so that it is adapta to any type spray finishing machine. T gun is 7 in. long, 2¾ lb. in weight, a can be supplied with mounting adapt that permit tipping and turning it to a position.

The fast action allows the gun to ope spray, and completely close 5400 times p hr. It is controlled entirely by an a operated piston. This construction is s



Small size, light weight, fast action a features of this automatic spray gun.

to provide positive, leak-proof shut-off fluid and air at the end of each spraying cycle.

All types of materials can be sprayed wi the gun. The same wide range of air ca and fluid tips used with the hand spray gu by the same manufacturer are interchang able on this gun.

Alloy Steels *Cut Costs*

...because they last longer in service–keep equipment on the job–reduce maintenance

● Sudden stress reversals, shock, strain, vibration and overloading just can't be avoided when heavy work must be done. But . . . their costly *effects* can be minimized by using Republic Alloy Steels for vital working parts.

Uniform response to heat treatment assures hard surfaces without sacrifice of toughness at the core—a combination essential to long life for working surfaces. Furthermore, Republic Alloy Steels have that extra strength needed to withstand heavy strains . . . extra toughness to absorb severe jars and jolts. And, they stubbornly resist the attack of fatigue.

The correct alloy analysis, plus proper design, can help you cut final equipment costs through improved service, reduced maintenance expense and longer life. Republic, world's leading producer of alloy steels, is ready NOW to help you use them most efficiently and economically. Write us.

lloy steels help keep rugged diesel tractors d bulldozers on the job—are used for trans- ission gears, recoil springs and fuel injection stem parts. For any equipment that must osorb plenty of punishment, Republic metal- rgists will be glad to suggest the proper alloy nalysis to solve *your* particular problems.

★ ★ ★

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
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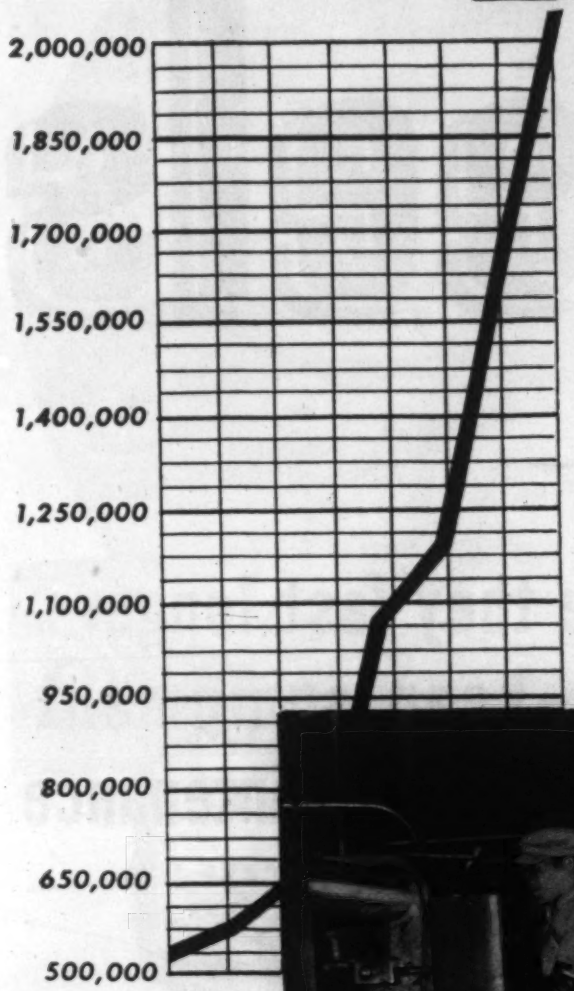
Republic REPUBLIC STEEL
ALLOY STEELS

Other Republic Products include Carbon and Stainless Steels—Sheets, Strip, Plates, Pipe, Bars, Wire, Pig Iron, Bolts and Nuts, Tubing

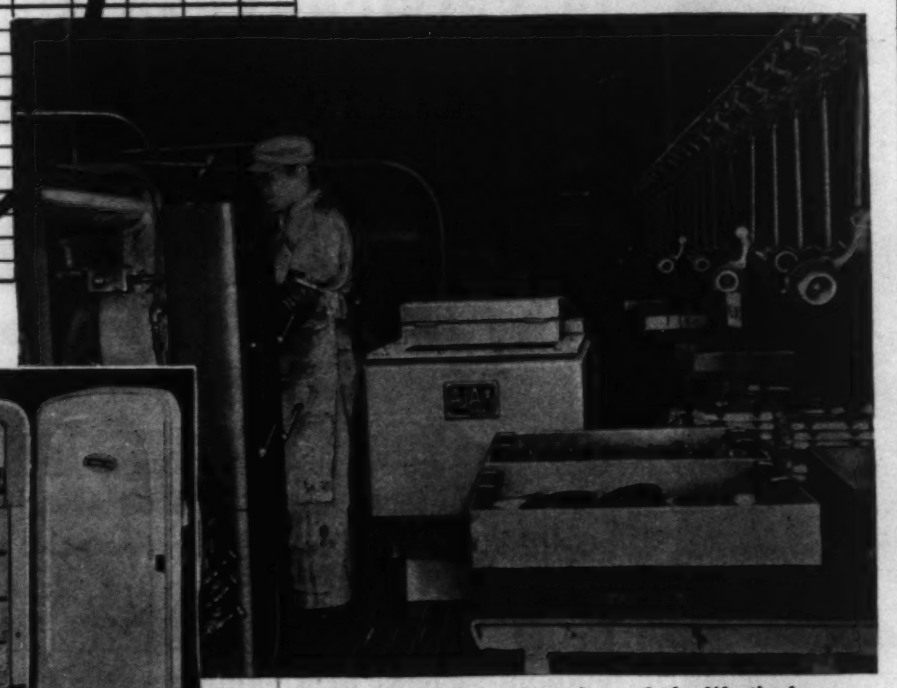
Over 2 Million



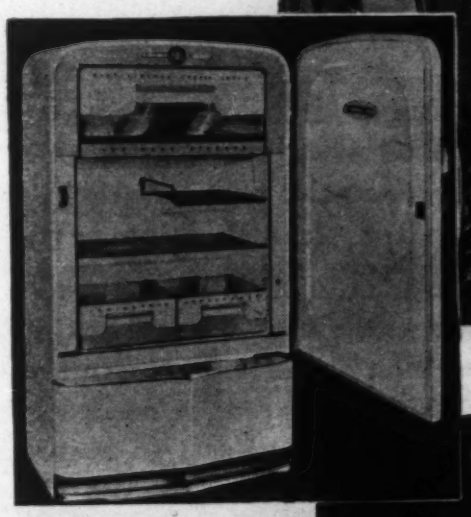
Electric Motors produced monthly in the U.S.A. --more and more manufacturers are installing

AJAX

ELECTRIC FURNACES to improve production.



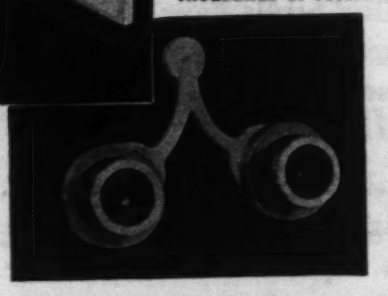
Part of the modern die casting plant of the Westinghouse Electric Corporation in Springfield, Massachusetts, where thousands of rotors are cast every day for refrigerator units.



The new Westinghouse Refrigerator Model MF-7.

•

Cast two at a time, these aluminum motor rotors are better because of accurate temperature control and freedom from contamination made possible by Ajax Induction Furnaces.



Included in the millions of motors manufactured nationally, per month, are the hundreds of thousands of fractional horse-power motors that fill the ranks of faithful, alert and silent servants for the American home. Such large output requires ingenious production methods. A great improvement has been achieved by casting the rotors from high purity aluminum. Prominent manufacturers have recognized the advantage of using Ajax-Tama-Wyatt induction furnaces for melting the aluminum prior to casting, because of the accurate temperature control and freedom from contamination with iron or silicon.

Write today for information about this modern method of increasing precision production.

AJAX ENGINEERING CORPORATION • Trenton 7, New Jersey

AJAX TAMA-WYATT **INDUCTION MELTING FURNACE**

Associate Companies: AJAX METAL COMPANY, Non-Ferrous Ingot Metals and Alloys for Foundry Use
AJAX ELECTROTHERMIC CORP., Ajax-Northrup High Frequency Induction Furnaces
AJAX ELECTRIC CO., INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ELECTRIC FURNACE CORP., Ajax-Wyatt Induction Furnaces for Melting

Furnace Uses Steam Protective Atmospheres

Scale-free tempering and strain relief of metal parts is achieved with a new line of steam-atmosphere furnaces, according to the manufacturer, *Leeds & Northrup Co.*, 4934 Stenton Ave., Philadelphia 44. High-speed steel tools, cast iron, sintered powdered iron compacts and nonferrous alloys are being treated by this method at temperatures up to 1150 F.

By adding a protective steam atmosphere to their forced-convection furnaces and Micromax temperature control, the method is said to provide parts free from scale, as well as parts having improved machinability and increased resistance to corrosion and wear. In addition, the parts are easier to clean for subsequent plating. High-speed tools, for example, exhibit improved life when cutting hard or abrasive materials. Powdered iron parts, after steam treating, have greater density and hardness.

Steam from a process line or a small boiler is fed into the work chamber through an inlet in the bottom of the furnace. Although especially designed for steam tempering, the furnace can also be run with natural air atmosphere.

Hydraulic Straightening Device Reduces Down Time

Firms operating boltmakers, nut formers and other cold heading equipment using heavy wire, or coiled hot rods, will be interested in the new hydraulic wire straightener developed by the *National Machinery Co.*, Tiffin, Ohio.

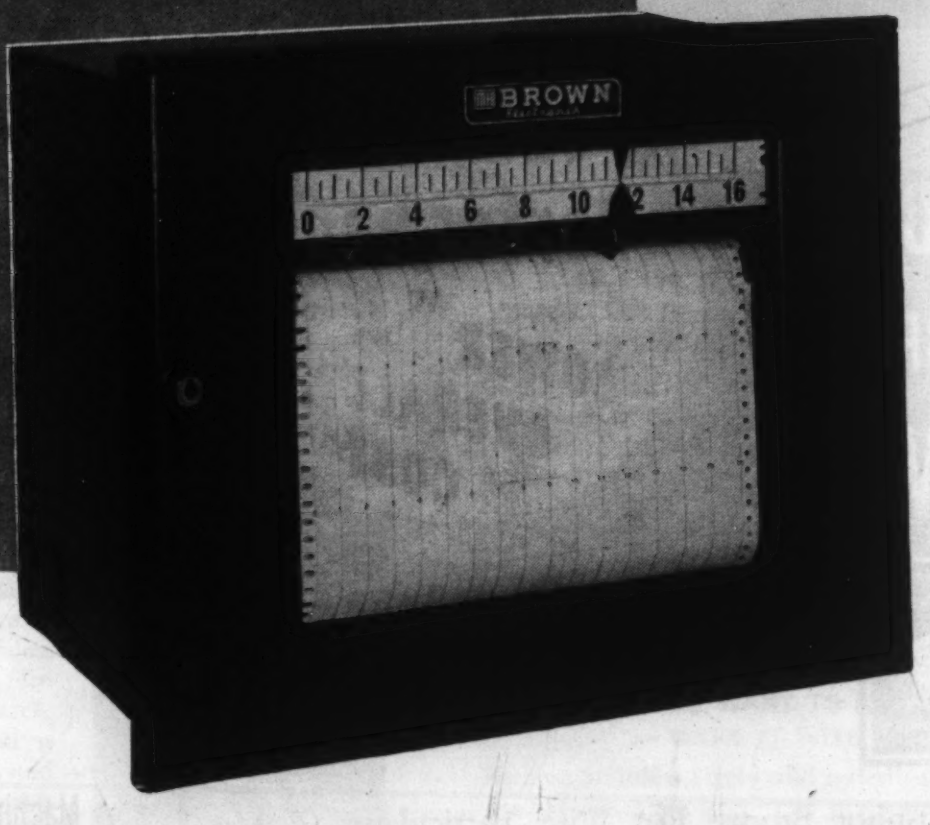
The device is said to reduce down time caused when feeding a new coil of wire into a machine by (1) mechanically straightening a length long enough to pass through the feed tube and rolls, and (2) supplying power to push the straightened length into the machine. Bending of the wire into a straight length, slipping or sawing off of crooked ends, and the manual pushing and tugging usually associated with feeding are eliminated. Another advantage is that a reserve coil may be prepared while previous coil is still being fed into the heading machine.

The straightener consists of a car which travels on a track frame. The two drums holding the wire coils can revolve on a shaft held stationary in a spindle head mounted on the car. Gripping bars are mounted on one end of the stationary track frame. Both the car and the bars are hydraulically powered.

The device is operated by placing the butt end of the wire in the gripping bars, which grip it hydraulically. The car holding the coil then moves the length of the track, thus straightening a long length of wire. After straightening, the grip bars are released, and when the previous coil has been consumed, the reel head mounted on the spindle is turned 180 deg., bringing the new coil into operating position. The straightened length is then brought into position for feeding. The car is then advanced, forcing the wire into the header

At last

ElectroniK Strip Chart Potentiometers With Electric Control



Allow More Exact Control Settings and Month-Long Continuous Records

The *ElectroniK* Strip Chart Electric Controller provides a combination of control action sensitivity and measurement accuracy heretofore unknown. The new instrument is available in both *contact* and *proportional* control models, and has the added advantages of more accurate control settings on the 11"-long scale and long-term continuous strip-chart records.

The new electric control styles round out the Brown *ElectroniK* Potentiometer line — giving the metal working industry a choice of indicating, circular or strip chart recording, electric or air-operated controllers, depending upon the particular application and requirements.

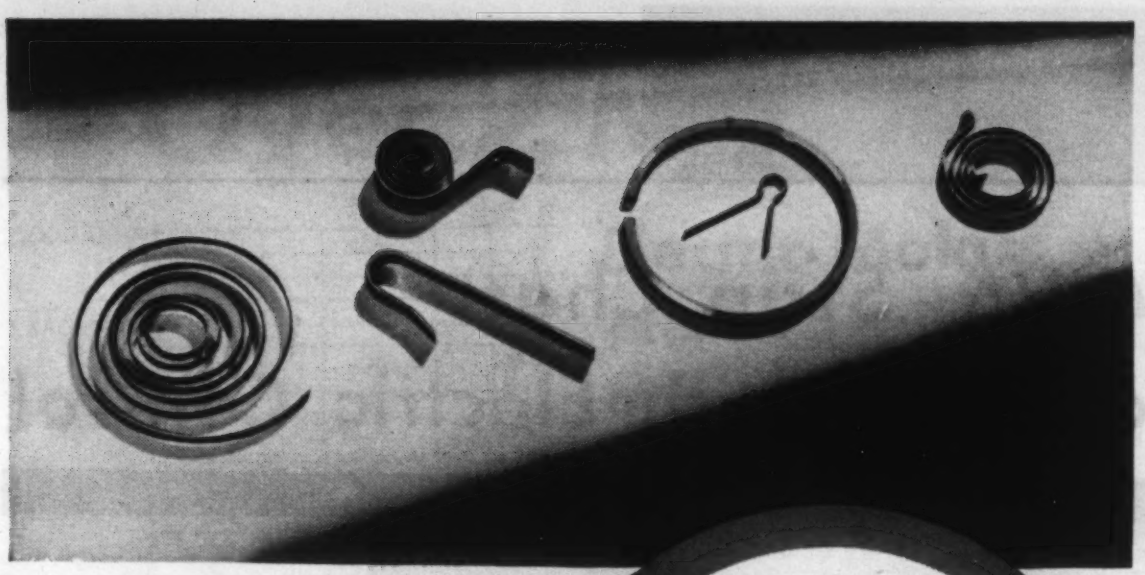
Write for the new catalog 15-13 which fully describes and illustrates the complete line.

Visit our exhibit at the National Metal Exhibition and Congress, Philadelphia, October 25-29. We invite your critical examination of the instruments displayed at Booth 203.

THE BROWN INSTRUMENT CO., 4517 WAYNE AVE., PHILA. 44, PA.
DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.

Offices in principal cities of the United States, Canada and throughout the world.

BROWN *Advanced Instrumentation* FOR BETTER PROCESSING — MINNEAPOLIS Honeywell



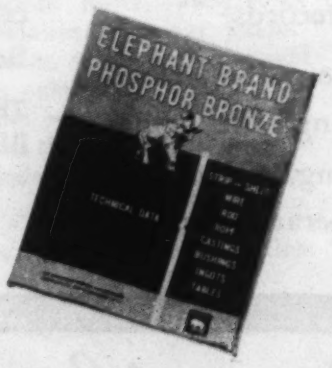
Typical examples of springs of Elephant Brand Flat Wire.

Elephant Brand
PHOSPHOR BRONZE
FLAT WIRE

Peak Performance AT LOWER OVERALL COST

Elephant Brand Phosphor Bronze Flat Wire, particularly 16 Metal (Grade A), is the preferred metal for many applications for it gives higher spring qualities than obtainable in slit strip, closer dimensional tolerances on both width and thickness plus a smooth edge (either round or square). Reflecting over seventy years of cumulative experience in originating and perfecting Elephant Brand Phosphor Bronze each spring made of this material has higher tensile strength, greater uniformity, more constant deflection rate, and higher resistance to fatigue.

Relay and contact springs of Elephant Brand Phosphor Bronze Flat Wire possess greater operational accuracy and longer life—factors that assure lowest installation and maintenance costs.



Our NEW Technical Data Book is available—you are invited to write for your copy.

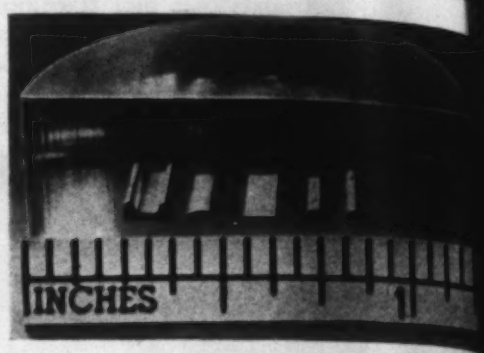
Elephant Brand
First name in PHOSPHOR BRONZE

THE PHOSPHOR BRONZE CORPORATION
Dept. B—2200 Washington Avenue, Phila. 46, Pa.

New Metal Ribbon Products Announc

Fine metal ribbon products suitable f jewelry, metal fabrics, coaxial cable, el tronic and instrument parts, textile cardi equipment and many other applicatio have been announced by *Sylvania Electr Products, Inc.*, Emporium, Pa.

The formed metal ribbons are produce by rolling and drawing nickeled steel, stai



A few of the many metal ribbon product now available.

less steel, copper clad steel, Inconel, copper beryllium copper, phosphor bronze, bras and aluminum. Available shapes, up t 1/8 in. in width, include channel, square rectangular, 1/4-in round, 1/2-round and fla ribbons in a wide range of thickness and special shapes.

Machine Grinds a Variety of Taps

Two taps can be ground at the same time on the two wheels of the new double end spindle type tap grinders developed by *Gallmeyer & Livingston Co.*, 295 Straight Ave., Grand Rapids 4, Mich.

The No. 2D-1 tap grinder of the new line will grind nearly all kinds of taps—pipe taps, pulley taps, nut taps, tapper taps, hand taps, machine taps, and with 2, 3, 4, 5 or 6 flutes. A special attachment for bent shank taps is available.

Any desired angle of entrance taper at the point of the tap can be ground on this machine. Whatever the angle, all flutes will be ground the same, which means that every land will do an equal amount of cutting. A diamond truing device with two diamonds is furnished as part of the standard equipment.

The spindle is equipped with double row ball bearings capable of resisting heavy combined radial and thrust loads. The bearings are grease-packed and are sealed for life.

The spindle is driven through vee-belts from the 1½-hp. motor mounted in the base of the machine. Belts can be replaced without dismantling the spindle assembly. The main column of the machine is a heavy, rigid casting. The weight of the machine, 900 lb., is sufficient for satisfactory operation without fastening to the floor, but holes are provided in the base for lag screws should they be desired.

If you can make it of steel
you can make it better with Stainless

(ESPECIALLY IF IT'S U·S·S STAINLESS STEEL)

DOES YOUR PRODUCT NEED GOOD LOOKS TO MAKE IT SELL? — MAKE IT WITH U·S·S STAINLESS

There's "buy-appeal" in the permanent beauty of U·S·S Stainless Steel. Its attractive appearance will dress up the most ordinary industrial equipment—in products bought by the public its eye-catching lustre often means the difference between profitable sales and costly inventories. U·S·S Stainless can be produced in any finish from a dull gray matte to brilliant mirror-polish. And because buyers know that its beauty goes through and through, can never wear or chip off, the demand for Stainless is greater than ever and is steadily growing.

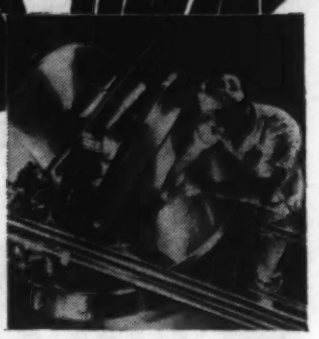
DOES IT NEED HIGH RESISTANCE TO CORROSION? — MAKE IT WITH U·S·S STAINLESS

No other commercial metal can match Stainless Steel in its high resistance to so many types of corrosives. Stainless Steel owes that resistance to a thin film that protects the surface from attack. At normal temperatures this film is transparent and invisible; at elevated temperatures it darkens and becomes a tight covering that helps to prevent further oxidation. U·S·S Stainless Steel's high corrosion resistance makes it especially valuable for chemical and food plant equipment, in textile machinery, in automobile and aircraft parts—and for kitchen utensils and other everyday products.

MUST IT WITHSTAND HIGH TEMPERATURES? — MAKE IT WITH U·S·S STAINLESS

Any material which is subjected to extremely high temperatures must be able to resist oxidation at those temperatures. It must at the same time retain much of its original strength. U·S·S Stainless Steel does both. Its high creep strength at elevated temperatures assures mechanical stability under severe operating conditions. Even in such exacting service as in refinery pressure vessels, in aircraft exhaust systems, cabin heaters and in jet engine combustion chambers where temperatures run as high as 1600 degrees F., U·S·S Stainless Steels give dependable service.

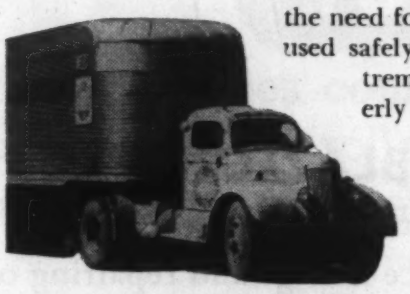
IS EASY CLEANING IMPORTANT? — MAKE IT WITH U·S·S STAINLESS



U·S·S Stainless Steel is so easy to clean that much of the cost, time and labor required in cleaning ordinary materials can be eliminated by its use. Stainless Steel's ability to resist adherence also results in appreciable cost savings. It is a fact that many materials—many food products, rayon gums, wood gums and resins, etc.—that adhere readily to common steel, will not adhere to Stainless. That is why Stainless Steel equipment can frequently be run for longer periods *without* cleaning.

DO YOU WANT TO REDUCE ITS WEIGHT? — MAKE IT WITH U·S·S STAINLESS

Because Stainless Steel—cold rolled to induce high tensile strength—is 2½ times stronger than plain steel, and because its superior corrosion resistance eliminates or reduces the need for corrosion allowances, it can be used safely in very thin sections to affect tremendous savings in weight. Properly designed products and equipment, built lighter of U·S·S Stainless, will withstand punishing service and long use, and will frequently cost little more than ordinary construction.



AND HERE'S WHY IT PAYS TO USE U·S·S STAINLESS STEEL

U·S·S Stainless is a perfected, time-tested stainless steel, so uniform in composition, in finish and in fabricating qualities that it allows the widest latitude in design and permits the use of the most advanced manufacturing techniques. It is available in the most complete range of forms, sizes and surface finishes anywhere obtainable.

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

USS STAINLESS STEEL — UNITED STATES STEEL

7-1242

UNITED STATES STEEL AMERICAN STEEL & WIRE COMPANY, Cleveland, Chicago & New York
CARNEGIE-ILLINOIS STEEL CORPORATION, Pittsburgh & Chicago · COLUMBIA STEEL COMPANY, San Francisco
NATIONAL TUBE COMPANY, Pittsburgh · TENNESSEE COAL, IRON & RAILROAD COMPANY, Birmingham
UNITED STATES STEEL SUPPLY COMPANY (Warehouse Distributors), Chicago · UNITED STATES STEEL EXPORT COMPANY, New York

Announcing... 2 new

J-M refractories for temperatures up to 3000 F.

new

3X FIRECRETE*

A castable refractory for special shapes and linings such as burner blocks, door linings, forge furnaces, etc. Easily withstands soaking temperatures of 3000 F.

new

3X BLAZECRETE

A refractory gunning mixture for building new furnace linings and repairing old ones. Can also be applied by troweling for heavy patching.

Both of the above new refractories have negligible shrinkage from application time to soaking temperatures of 3000 F. Both possess unusually high spall resistance. Each is furnished in 100-lb. bags. See your authorized distributor for further information, or write to Johns-Manville, Box 290, New York 16, N.Y. **Reg. U. S. Pat. Off.*

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville FIRECRETE
The Standard in Castables

Two New Plastics Announced

Two new plastics have been recent announced by the *Plastics Dept., Americ Cyanamid Co.*, 30 Rockefeller Plaza, N. One of these is a urea-formaldehyde mol ing material (Beetle). Applications for th new material include such items as closure buttons and wiring devices. It is current available in limited quantities.

The other plastic is a melamine-formald hyde molding compound .(Melmac 404) The new material was developed specifica for use in the manufacture of high-glo buttons and is currently available in limite quantities.

● *The Hardesty Chemical Co., Inc.*, 4 E. 42 St., New York 17, has announced dicapryl sebacate to the trade as a plasticizer for vinyls. This compound imparts flexibility, which is maintained down to -75 F. The resistance of dicapryl sebacate plasticized vinyl film to volatility loss is reported at less than 1% loss in 24 hr. at 250 F in moving air current. Excellent water resistance and exceptional light and aging resistance characteristics are attributed to this plasticizer. Its high purity and constancy of good color permit the widest range of use of pigments and color combinations.

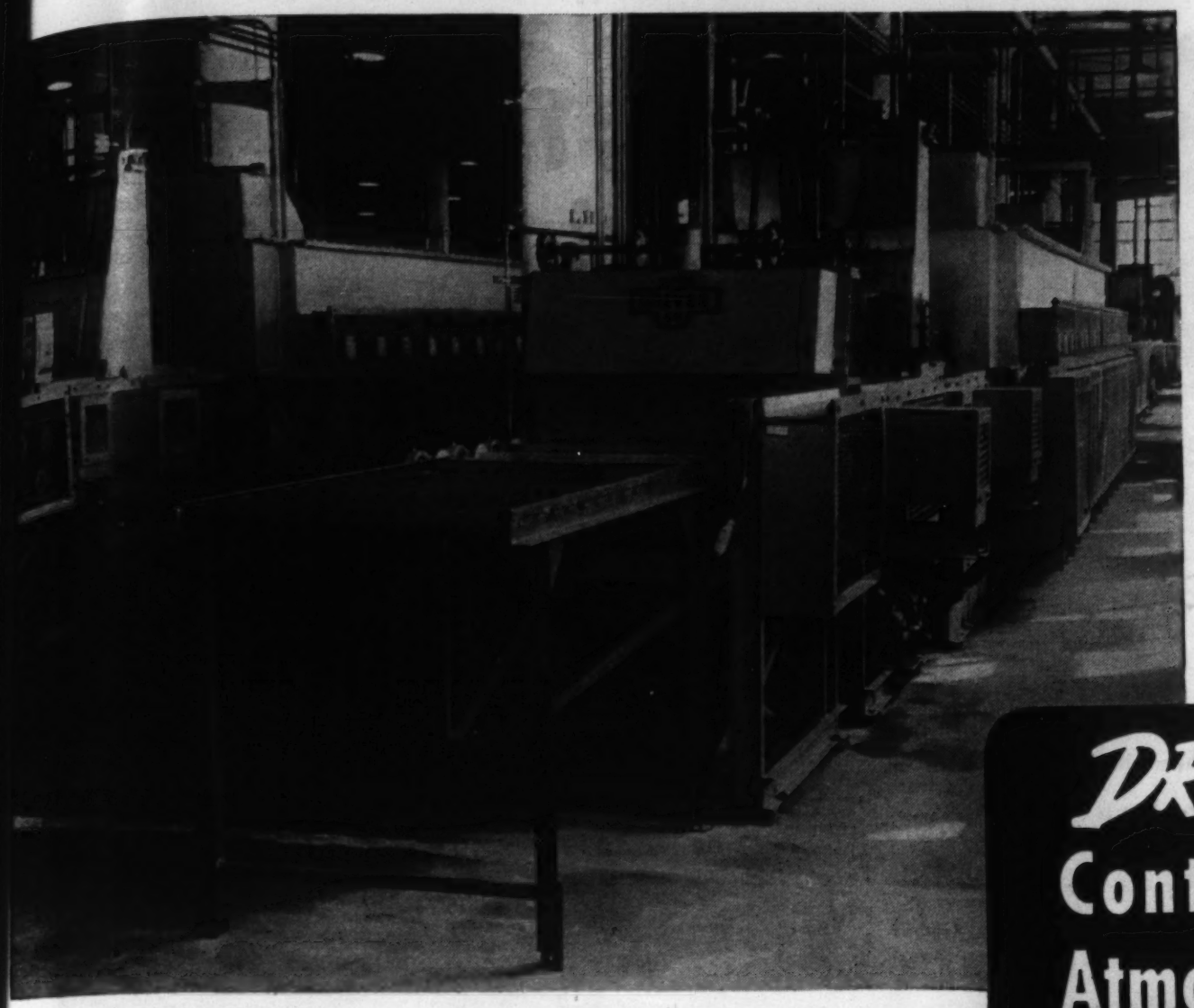
Gun Designed for Sand Blast and Liquid Spray

A combination blast gun, manufactured by *Engineered Products, Inc.*, 1224 Speer Blvd., Denver, Colo., is designed for surfacing, cleaning and finishing in the automotive and industrial fields. Air operated and portable, the blast gun, known as the Tornado, is particularly useful in reaching inaccessible places, such as wheels, drip mouldings, grill work, brick and rough finished walls, rungs, spoolings, steam radiators, fins, odd shapes, corners, crevices, and close fittings.

It can be connected to any air line, and is equipped for sand blast operations or spraying solvents and liquids. The nozzle is changed by loosening a retaining nut and putting another nozzle in place.

Two attachments are supplied with the gun: a case-hardened nozzle for use in blast operations, and a nozzle for use with oils or chemicals.

The unit is equipped with a 3-pint container, and is designed for locking with a quarter turn. The turbulence shield is designed to stop and retain the bulk of spent abrasive that ricochets from the surface being worked. The maximum air consumption is 9½ cu. ft. per min. at 100 to 150 lb. pressure.



Two (2) 330 KW. Atmosphere Roller Hearth Furnaces

DREVER Controlled Atmosphere ROLLER HEARTH FURNACES

for Bright Annealing, Clean Hardening, Sintering, and Brazing

Drever Atmosphere Roller Hearth Furnaces combine the speed and efficient material handling of the roller hearth with the advanced engineering design of Drever controlled atmosphere furnaces.

Drever Roller Hearth installations include all types of firing, a wide range of atmosphere; and sizes to meet specific requirements.

VISIT US AT BOOTH 1653
30th NATIONAL METAL CONGRESS
IN PHILADELPHIA

Our Engineering Department will be glad to show you the inherent advantages of Atmosphere Roller Hearth Furnaces.

DREVER CO.

750 E. VENANGO ST., PHILA. 34, PENNA.

CONTINUOUS FURNACE LINES, HEAT TREATING FURNACES, DESCALING & ATMOSPHERE EQUIPMENT

NEW YORK & NEW ENGLAND—GERALD B. DUFF, 68 CLINTON AVE., NEWARK 5, N. J.
W. PENNA., W. N. Y. and OHIO—H. C. BOSTWICK, 3277 KENMORE RD., CLEVELAND 22, OHIO
IOWA, MINN. & WIS.—WALTER G. BARSTOW, 1302 FIFTH AVE. SOUTH, MINN. 4, MINN.

HOW FAST CAN YOU CHECK THIS FOR ROUGHNESS?

With the Profilometer, it's a matter of *seconds!*

This instrument has a tracing speed of 1/3″ or more per second —so a 10″ piece like the one illustrated can be measured *from end to end*, externally or internally, in less than half a minute. Similar speed is provided in measuring surfaces from 1/32″ up to *several feet* in length; and no technical knowledge or special skill is required.

Ease and speed of operation are two good reasons why hundreds of plants are using the Profilometer as standard shop equipment. Consistent accuracy is another. When the reading is taken, that's *it*. Any other operator will obtain the *same reading*, in *definite microinch units*.

And the Profilometer makes practical the advantages of *surface roughness control*. With this instrument, many plants are bringing their work more rapidly to final size and finish—often with fewer operations. They're shortening their set-up time. They're getting closer *dimensional* control—often detecting impending dimensional errors *before they occur*. In other ways, too, they are making big savings in time and material—savings which quickly repay the investment in equipment.

***Write for complete information* on the Profilometer and its many applications—and arrange for a demonstration in your plant. You may be surprised to learn how this and other PRCo shop instruments can help lower your break-even point.**

***Profilometer* is a registered trade name.**

A SURFACE CONTROL INSTRUMENT BY

PHYSICISTS RESEARCH COMPANY

ANN ARBOR • MICHIGAN

Rubber Gaskets, Washers, Sleeves for Many Fields

A standard line of punched or extrud rubber gaskets, washers and sleeves has be announced by the *Stalwart Rubber Co.*, 1 Northfield Rd., Bedford, Ohio. This n line of products has been designed to ha applications in automotive, plumbing, el trical and other general manufacturing fiel

Gaskets, washers and sleeves are ava able in such synthetic rubbers as Buna Neoprene, Butaprene (Hycar and Buna N and Thiokol; and in natural or reclaim rubbers. Certain compounds are availab to provide rubber products with maximu resistance to acids and alkalies. Oxide additives provide rubbers with weatherpro qualities.

Capable of withstanding normal temper tures of from –60 to 225 F, rubbers c have durometer hardness range of from 3 to 100, tensile strength of from 500 3500 psi., and elongations from 50 900%.

Standard slip joint washers are availabl in sizes having 1¼-in. I.D. by 1-7/16-in O.D. by 3/16 in. up to 1⅞-in. I.D. b 2-1/16-in. O.D. by 3/16 in. Union washer are available in sizes from ⅜-in. I.D. b 1-1/16-in. O.D. by 3/32 in. up to 2¼-in I.D. by 3-1/32-in. O.D. by 3/32 in. Bibb washers can be furnished in sizes from ¼-in. O.D. up to 1½-in. O.D.

● A galvano-chemical process for brightening aluminum has been developed by the *Philadelphia Rust Proof Co.*, 3229 Frankford Ave., Philadelphia 34. Reflectors spun of aluminum and then brightened by this process are said to retain their lustre and do not smudge or fingermark. If added protection is desired, they may be anodized with little diminishing of reflectivity. The process, called Lustrik, appears also to have value in plating on aluminum, painting on aluminum, and dyed anodic coatings.

New Sealant Salvages Porous Metal Castings

A new chemical sealant is available from *Western Sealant Co.*, 9093 W. Washington Blvd., Culver City, Calif. Designed primarily for the impregnation and salvage of low density metals, such as aluminum and magnesium alloys, it can be applied also to castings of bronze, steel and gray iron. Its application is clean, and surfaces, ducts, pockets or machined areas show no visible sign of the treatment. Coatings such as anodizing or plating can be applied either before or after impregnation.

According to the manufacturer this sealant is able to insure pressure tightness usually with one impregnation, and will not

MACHLETT Industrial Thermax

The accepted standard in the 150 KV range

This shockproof, light-weight unit was designed for maximum maneuverability where space is limited. The small-sized housing is rotatable through 360°. Its superior mechanical and electrical characteristics have assured its position as the most widely used tube in this voltage range.

The Industrial Thermax provides high continuous ratings for most fluoroscopic applications (Example: 150 PKV, 9 MA continuous), and has ample capabilities for the penetration of moderately thick sections of steel or other heavy materials.

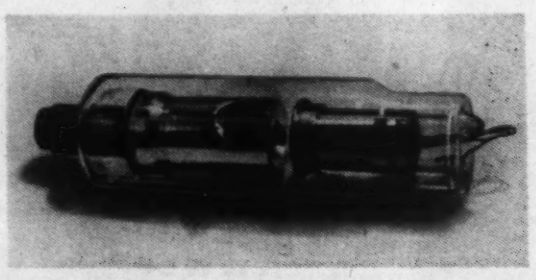
The present Thermax, as a result of continuous improvement, offers greater capacity and ruggedness than ever before and without change in external dimensions. Thus, the tube can be used as a replacement in your present equipment.

COOLING: Heat dissipation is rapid. Two models: water-cooled and oil-cooled. Latter features a system of supplying the oil in a highly efficient jet discharge. Metal in cooling system is corrosion-proof super-nickel.

INSERT: Closed hood with beryllium window surrounds target; space within hood is field-free, minimizing wall bombardment and stem radiation.

SHIELD: Ray-proofing by a heavy copper hood. A lead-loaded bakelite shield insures greater electrical stability and inhibits internal scattering.

Full details of this outstanding contribution to an important and growing field will be sent on request. Write Machlett Laboratories, Inc., Springdale, Connecticut.



The improved Industrial Thermax Insert: 150 PKV, 20° target angle, 2.3 mm. focal spot, either water-cooled or forced-air-cooled.

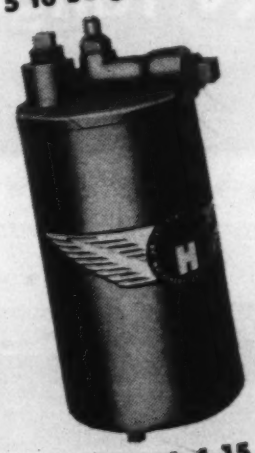
MACHLETT

X RAY TUBES SINCE 1897

TODAY THEIR LARGEST MAKER

HOFFMAN
Disc Filters

MODEL I 6-15 D
5 to 50 g.p.m.



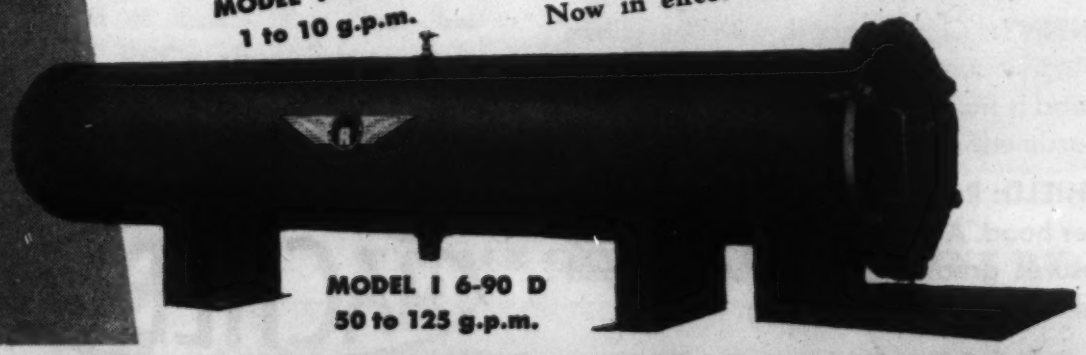
MODEL I 4-15 D
1 to 10 g.p.m.

Originally designed for aircraft, the Hoffman Disc Filter has been adopted and improved for industrial applications. Thus, you can get continuous flow of clean coolant, even in "cramped quarters". First cost is low . . . no moving parts to get out of order . . . minimum maintenance.

Three sizes of this practical, efficient filter will remove dirt particles measuring from 3 to 5 micro inches. For further details and an estimate of the correct size for your requirements, write today.

NEW LOWER PRICES!

As more and more companies turn to Hoffman Disc Filters, increased production brings you new lower prices. Now in effect—ask us about them.



MODEL I 6-90 D
50 to 125 g.p.m.

U. S. HOFFMAN MACHINERY CORPORATION
223 Lamson St., Syracuse, N. Y.
COOLANT FILTERS • FILTRATION ENGINEERING SERVICE

"bleed out" in curing. It is chemically unaffected by hydrocarbons, other petroleum products or glycols. Water, solvents, salts and moderate acids or alkalis have little or no effect on it. The sealant is a thermosetting copolymer; the viscosity can be controlled to meet a range of requirements and insure proper flow into all pores of the casting.

A typical group of castings that were salvaged by use of the new sealant.

Small castings are impregnated by a vacuum-pressure method employing 29 in. of vacuum and at least 100 psi. pressure. Large castings are sealed by an internal pressure method. In either case the sealant is forced into every pore in the casting. The part is then cured by dry heat.

● The *Cal-Perry Corp.*, 62 Franklin St., East Orange, N. J., has announced the availability of a soldering iron tip for use with electric soldering guns. The unit is a chromium-plated copper electrode with only the surface of the tip exposed to prevent heat loss. Heating time is only 9 sec. The electrode is guaranteed for six months and will not break or "eat-through." The heat generated is sufficient to cover average soldering needs.

Creep Testing Machine Features Chart Recorder

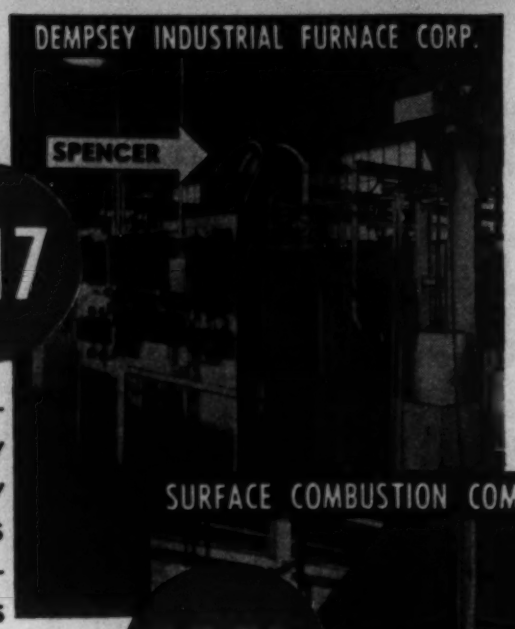
A new motor-driven, screw-type creep testing machine of 20,000-lb. capacity, designed for short-time, creep-rupture tests at high temperatures, with a minimum of operator attention, has been announced by the *Baldwin Locomotive Works, Testing Equipment Dept.*, Philadelphia 42. The machine automatically maintains constant loads up to 100,000 psi. on standard 0.505-in. dia. specimens while temperatures are held constant up to 2200 F. Tests of this type can run for 10 to 400 hr.

A feature of the machine is a flat 10-in. by 10-in. chart recorder panel in front, with which no extensometer is required and no strain readings need be made. The elonga-

(Continued on page 154)

Since 1917

The first Spencer Turbo was installed in 1917. Many of the early machines are still in service. A few of the equipment manufacturers that have used Spencers consistently (see dates) for many years are represented on this page.



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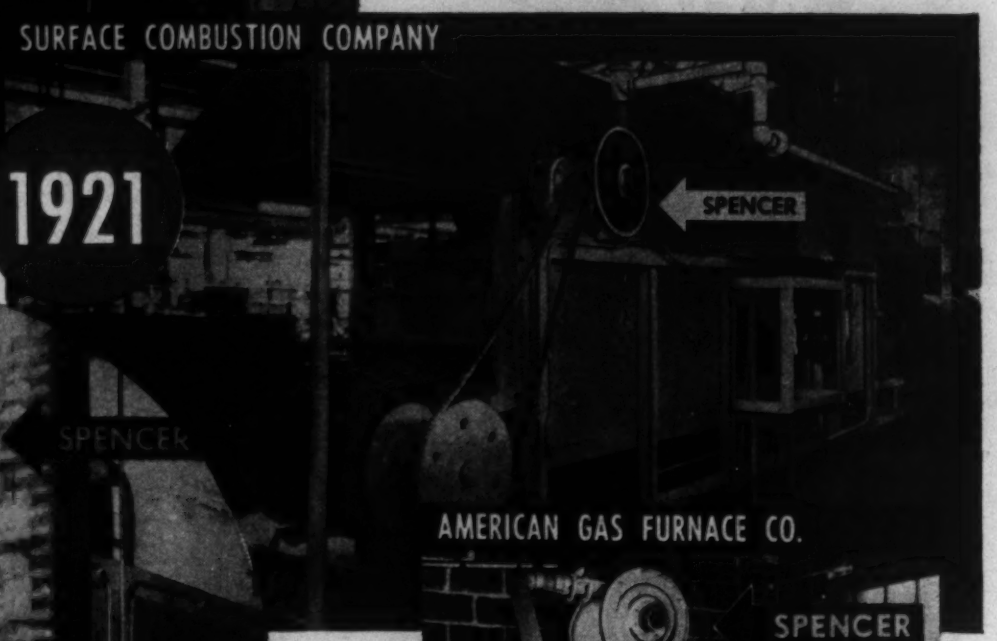

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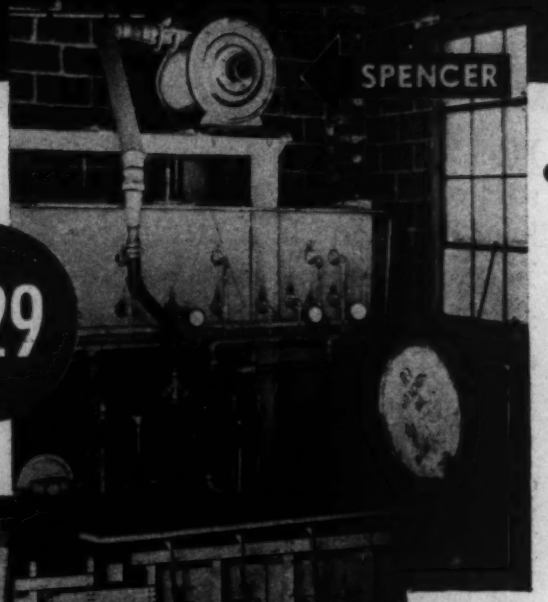

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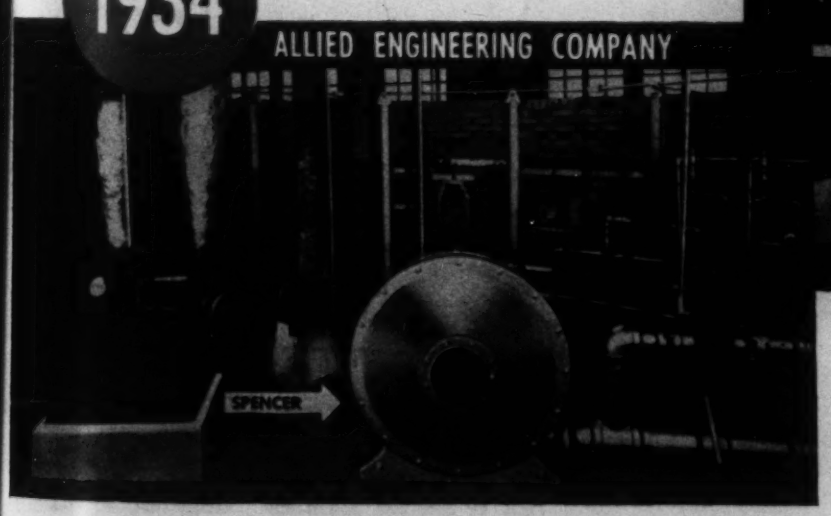
1934



Standard sizes from 35 to 20,000 cu. ft.; ⅓ to 800 H.P.; 8 oz. to 10 lbs. Single or multi-stage, two or four bearing. Special gas-tight and non-corrosive construction available.

Special Spencer Bulletins are available as follows: Data, No. 107, Gas Boosters, No. 109, Four Bearing, No. 110, Blast Gates, No. 122, Foundries, No. 112 and the General Bulletin is No. 126.

359-F

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONN.

SPENCER HARTFORD

TURBO-COMPRESSORS

See Spencer at Booth No. 217

for WET jobs?

Here's a beer cooler, designed to hold ice and water, catch beer foam, and look attractive. Naturally it must have a corrosion-resistant, indestructible, easy to clean surface, with negligible water absorption, and must not warp or distort hot or cold. All these things at lower cost! That's why it's molded in one piece of gleaming black Ace hard rubber.

Your designs too may profit from the distinctive advantages of the hard rubber or plastics compounds molded or extruded by Ace—for corrosion resistance is only *one* of many big reasons for selecting Ace. If you would like to know more about these Ace materials —where used, properties, design hints, etc.—just write on your company letterhead for the new 60-page Ace Handbook.

ACE HARD RUBBER & PLASTICS
AMERICAN HARD RUBBER COMPANY
11 MERCER ST., N. Y. C. 13

tion versus time curve is automatically and accurately drawn on the chart from the start of the test until rupture occurs. This is said to assure much greater accuracy at the final point of the curve, or for plastic strain at rupture, than has hitherto been possible by the conventional practice of measuring after rupture by fitting the two broken ends of the specimen together.

The specimen is loaded below through gearing by means of a large, electric-motor-driven screw having a stroke of approximately 4 in. The top end of the specimen is supported by a stiff, heavy spring block on which the constant load is maintained by keeping a constant deflection. The deflection of the spring block is measured by a dial gage with an electrical contact. The electrical contact controls the motor that drives the screw. Thus, a constant deflection is maintained in the spring block and a constant load is applied on the specimen during its elongation. When the specimen ruptures, the control circuit (of which the specimen is a part) is broken and both motor and clock are stopped.

● A new heat-resistant dry grinding belt has been announced by *Behr-Manning,* Troy, N. Y. Utilizing special heat-resistant, thermosetting resin adhesives instead of the conventional glue-type adhesives, the new belts are said to remain sharper, longer. Substantial production increases both in number of pieces per man-hour and in the number of pieces per belt have been reported on heat-generating operations.

Sheet Feeding Table Has 16-In. Lift

To supplement their line of hydraulic elevating sheet feeding tables, *Lyon-Raymond Corp.,* 6215 Madison St., Greene, N. Y., has designed a new 10,000-lb. capacity unit which has a 16-in. range of elevation.

The top of this new Model 66 table is 36 in. wide by 66 in. long. Side extensions can be provided which will increase the width to 48 in. and end extensions are available which will extend the length to 96 in.

For many sheet feeding jobs, a 16-in. lift was desirable because shorter and more compact bundles were being handled as 5-ton loads. The new table has a lowered height of 26 in. and an elevated height of 42 in., so that the top of the pile can always be maintained at press bed height until the last sheet is handled.

The table is portable and can be loaded in a storage area and maneuvered into place by an industrial power truck for which a towing eye is provided.

Standard equipment includes a 2-speed foot pump with 5 ft. of hydraulic hose so that it can be placed in a position which will be convenient to the operator during the sheet feeding operation. A floor lock is also provided.

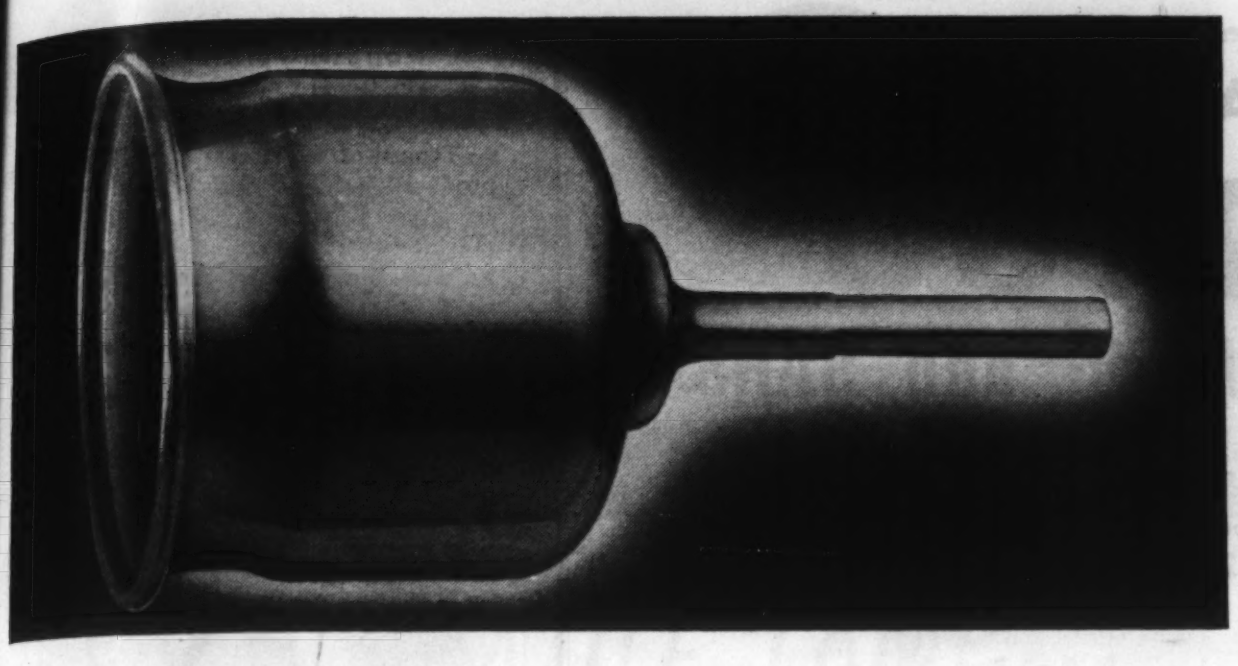
3 steps *to* **HIGHER PRODUCTION** *and* **LOWER COST**

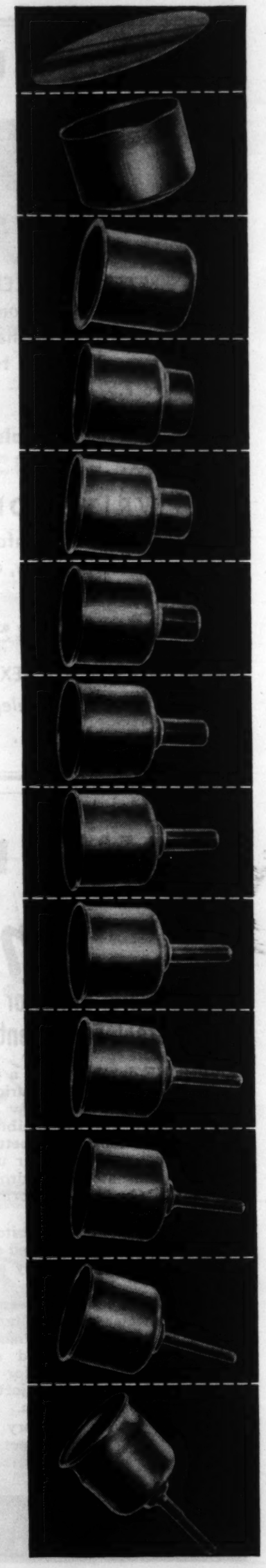
1. *Consult* the Milford free engineering service

2. *Choose* one of 15 basic Milford rivet setting machines — offering unlimited versatility.

3. *Select* exactly the right semi-tubular or split rivet or cold-headed fastener from Milford's complete line.

MILFORD RIV-IT & MACHINE COMPANY
1000 MERWIN ROAD, MILFORD, CONN.
1000 WEST RIVER ST., ELYRIA, OHIO





How deep can you draw Aluminum?

This upper bowl of a commercial vacuum coffee maker started as a 14½-inch circle of Kaiser Aluminum. In 12 progressive stages it was drawn to a 6⅜-inch bowl with a tubular stem ¾-inch in diameter and 6⅜ inches long. A total reduction from circle to stem of approximately 95%—*without a single anneal!*

Lower fabricating costs!

Because of Kaiser Aluminum's excellent quality and workability, extra steps are saved, and handling and fabricating costs are reduced. Scrap loss is cut. Tooling setup costs are low. And with aluminum, plating is unnecessary because a bright, lasting finish can be obtained by buffing.

The result is a low-cost product that can't rust, chip or break. And that can't be matched for sales appeal!

What does this mean to you?

It means that with Kaiser Aluminum you have a quality metal capable of meeting the toughest manufacturing requirements. A *versatile* metal that combines strength, durability, lightness, workability, and that can never rust.

It means, too, that you can have the services of thoroughly experienced engineers, expert in selecting the right alloy for the most complex job, and capable of assisting in your most difficult fabricating problems. May we tell you more?

For another dependable source . . . choose

Kaiser Aluminum

product of Permanente Metals Corp.

SOLD BY PERMANENTE PRODUCTS COMPANY, KAISER BUILDING, OAKLAND 12, CALIFORNIA . . . WITH OFFICES IN:

Atlanta • Chicago • Cincinnati • Cleveland • Dallas • Detroit • Houston • Indianapolis
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STEEL TUBING and BARS

PETERSON STEELS, INC. maintains the largest stock of high carbon-chrome (52100 type) steel, seamless tubing and round bars in the country. More than 200 sizes of tubes from .875" O.D. to 8.231" O.D. Bar stock from .171" round to 7.5" round.

Ring forgings also supplied quickly — any analysis, any size.

WRITE FOR CURRENT STOCK LIST

Contains full information on all available sizes, finishes, etc. Write today, on your business letterhead, for your copy.

PETERSON STEELS, INC.

DEPT. A, 420 LEXINGTON AVE. · NEW YORK 17, N. Y.

***Telephone:* MUrray Hill 5-1560**

NEWARK, N. J. · DETROIT, MICH. · CHICAGO, ILL.

New! ENTHONE *Inhibitor 9*

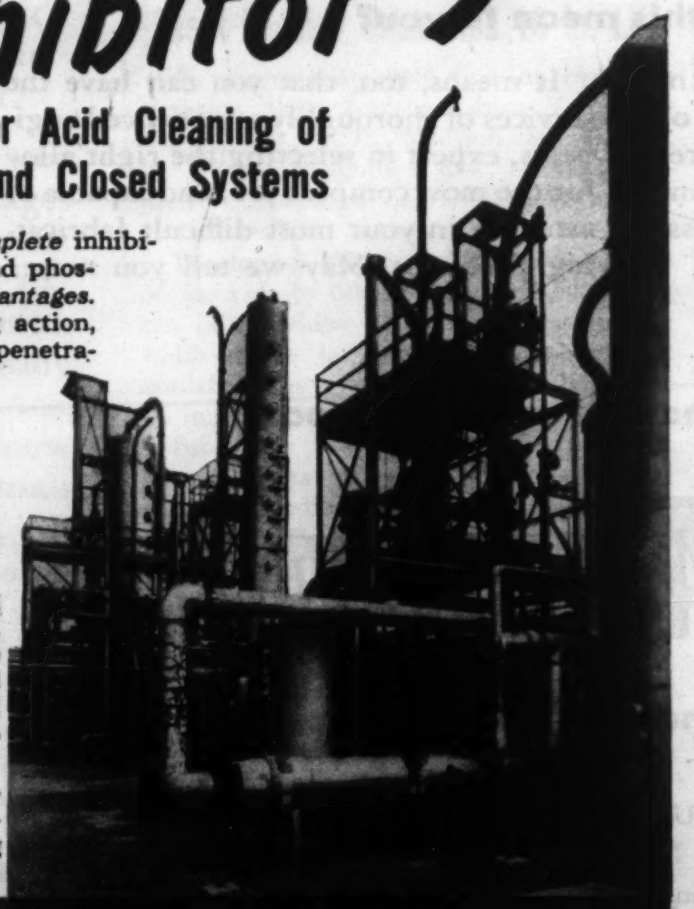
A New Safe Inhibitor for Acid Cleaning of Large Steel Equipment and Closed Systems

ENTHONE Inhibitor 9 is a *complete* inhibitor for hydrochloric, sulphuric and phosphoric acids with many *new advantages.* These include 98-99% inhibiting action, lower surface tension for better penetration, rust retarding after use, reduction of atomic hydrogen absorption (hydrogen embrittlement), no odor, tasteless.

Use only one pint of Inhibitor 9 for each carboy of acid added and save the cost of proprietary acid mixtures.

For pickling and safe cleaning of boilers, water systems, tanks, towers, condensers, drums, marine equipment, radiators, food and processing equipment; — for all systems and apparatus subject to scale formation or corrosion.

Inhibitor 9 possesses every advantage needed for a perfect inhibitor for all non-oxidizing mineral acids.

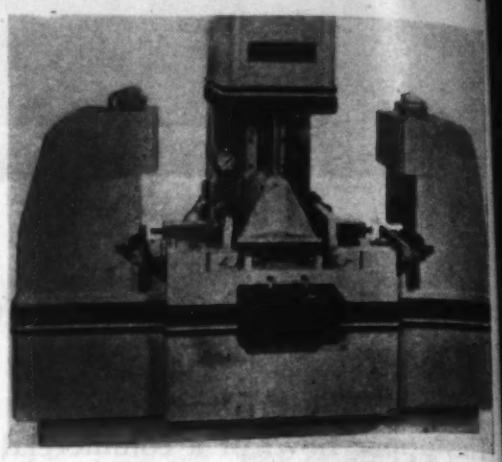


ENTHONE, Inc. · 442 ELM STREET, NEW HAVEN, CONN.

Stretch Forming Machine Performs Three Operations at Once

Typical of the stretch forming equipment produced by *Cyril Bath Co.*, 6901 Machinery Ave., Cleveland, is a new automatic machine wherein three separate forming units are employed to perform three major bends in shaping complete tub sides and back of a dish washing machine.

The two outside heads contain forming slides which automatically and simultaneously form the curl and the reverse lip



View of the new cabinet forming machine used in shaping parts for dish washing machine.

on the extreme ends of the part. These slides actuate hydraulically, retract automatically, and through sequence control, the center forming punch descends, making the two large radii bends with the assistance of wing-type rocker plates. Controls are provided and arranged so that the machine can be run either automatically or manually.

Another similar machine forms the entire complicated bottom of the dish washer in one operation instead of six operations, previously required with conventional equipment. Cold rolled enameling steel of 18-gage and 20-gage is used. The machine turns out approximately 40 cabinets per hr.

Antiseptic Coating for Metals

A novel process for producing antiseptic metal surfaces, notably on aluminum, magnesium, zinc and tin, has been developed by *Benzol Products Co.*, 237 South St., Newark, N. J. It is well known that bacterial and fungal growths often occur on the metal surfaces of food, cosmetic and pharmaceutical containers and closures, on optical equipment such as cameras, binoculars and range finders, and on metal articles and structural parts used in the food, drug, beverage and other industries. Such growths are said to be effectively arrested by this method of treatment.

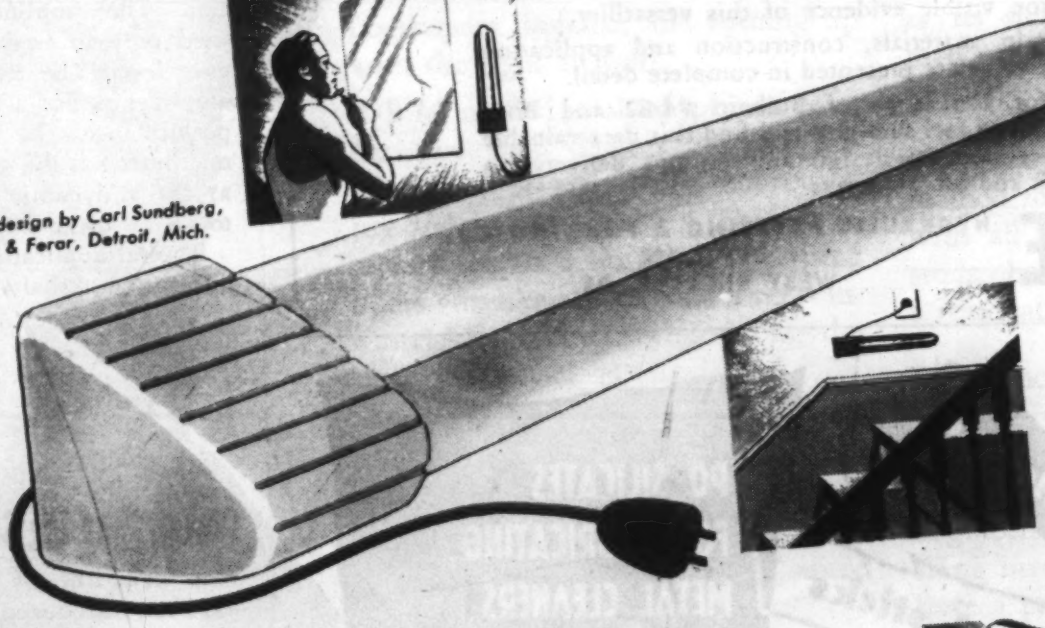
To create the antiseptic coating, the metal surface is first oxidized either electrolytically or chemically and then simply immersed in a solution of 8-hydroxyquinoline or one of its salts. Colored antiseptic coatings may be produced by the addition of dyes to the 8-hydroxyquinoline solution. A one-step method of oxidizing and rendering metal surfaces antiseptic is also possible.

NEW
PRODUCT IDEAS
WITH
CELLULOSIC PLASTICS

A VERSATILE LAMP...

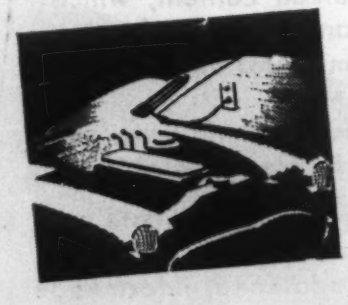
IN VERSATILE CELLULOSE ACETATE

Suggested design by Carl Sundberg,
Sundberg & Ferar, Detroit, Mich.



Upstairs, downstairs, in milady's boudoir . . . here's a portable fluorescent lamp that is right at home anywhere. Colorful and lightweight base and reflector are made of acetate . . . *rugged* and *tough*. Sturdy one-piece base holds lamp ballast and wire reel . . . strong suction cups affix it to any surface in whatever position is desired. It's another fine example of the limitless design potentials of acetate—the most versatile of all thermoplastics.

New formulations of high-acetyl acetate provide an improved degree of dimensional stability, heat resistance, low-moisture pick-up, and flame resistance, yield products of consistently high quality. There's place for acetate in your product picture. For detailed information write:



HERCULES POWDER COMPANY
INCORPORATED
996 Market Street, Wilmington 99, Delaware

SUPPLIERS OF HIGH-QUALITY CELLULOSE DERIVATIVES FOR PLASTICS

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CELLULOSE ACETATE • ETHYL CELLULOSE • NITROCELLULOSE

FOR THE LATEST STORY ON

LENAPE TYPE R AND SR MANWAY

NECKS . . . NOZZLES . . . COVERS

Write for BULLETIN #4-82

Standard and Special Lenape Type R and SR Manways provide a flexibility in vessel design which *is* important to all users—Bulletin #4-82 gives you visible evidence of this versatility.

Size range, style, materials, construction and application information of value are presented in complete detail.

Write today for your copy of Bulletin #4-82 and Price Schedule M-48—we feel sure you will find this data valuable reference for economical design and prompt delivery on Lenape Type R and SR Manways.

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 102
WEST CHESTER, PA.

Micrometer Measures Without Touching Parts

A dynamic micrometer has been developed by *Electro Products Laboratories, Inc.*, 549 W. Randolph St., Chicago 6, which when used with the Du Mont Model 208 Oscillograph or the equivalent, will measure movement, radial displacement or vibration of any part made of ferrous material. The micrometer does not touch the moving part, and, therefore, does not interfere with its movement. The displacement is read in tenths of a thousandth of an in. with an accuracy comparable to that obtained with a standard micrometer.

Readings are made on a conventional micrometer sleeve about 2 in. in dia., which is directly calibrated in thousandths and tenths of thousandths of an in. without resorting to a vernier. The performance of the dynamic micrometer is independent of acceleration or the frequency of the displacement.

All amplification is done at a constant "carrier" frequency which changes in amplitude with changes in displacement or vibration. The amplifier and oscillograph are used only to establish an amplitude reference level. The frequency responses of the amplifier is not a factor in the accuracy of performance. The accuracy of the dynamic micrometer is the same for a static condition as for a dynamic condition corresponding to speeds up to 200,000 rpm.

Typical applications are measuring movement of crankshafts or other rotating bodies.

for flash plating that sticks

PQ SILICATES FOR FABRICATING METAL CLEANERS

Metso Granular
($Na_2SiO_3.5H_2O$) Sodium Metasilicate. Free-flowing, white granular product.

Metso 99
($Na_3HSiO_4.5H_2O$) Sodium Sesquisilicate. White, granular, free-flowing.

G-C Brand
($Na_2O.2SiO_2$) Powdered Sodium Silicate. Hydrated, alkaline. Readily soluble.

SS-C-Pwd
($Na_2O.2SiO_2$) Anhydrous Silicate. Slowly soluble. Ground to pass 65 mesh.

Be sure that your cleaner contains a PQ silicate detergent such as Metso Granular or Metso 99. Thus you get the benefit of balanced silica-alkali content, which brings about spontaneous emulsification of oily or greasy films. And then a special property of Metso is its efficient suspending action so that the dirt is kept free of the clean metal.

It pays to be informed about silicate's ability to deliver chemically cleaned surfaces. Write for additional information.

PHILADELPHIA QUARTZ COMPANY
1133 Public Ledger Bldg., Phila. 6

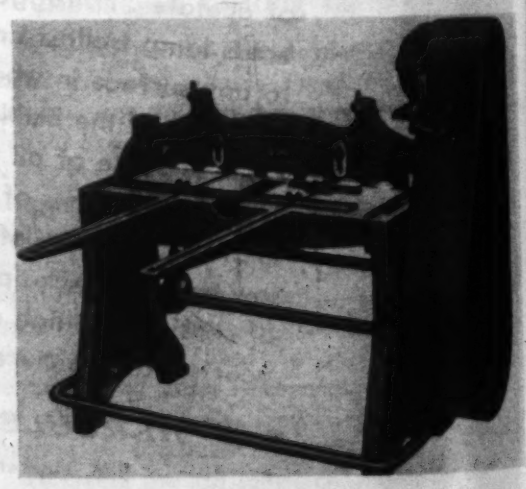
metso® cleaners

Sodium Sesquisilicate U S. Pat 1948730, 2145749 Sodium Metasilicate U.S. Pat 1898707

Power Squaring Shears for Light Gages

A new line of power squaring shears has been introduced by *Famco Machine Co.*, Racine, Wis. The new power shears are capable of cutting 18-gage stock. Three models are available: 36 in., 42 in., and 52 in. Their respective shipping weights with motor are 1050, 1200 and 1400 lb.

The shears have inlaid, precision-ground,



Three models of this light weight power squaring shear are available.

high carbon tool steel blades, adjustable front and back gages, and hold-downs and guards. The shears have special single stroke mechanisms which can be easily set for continuous operation.

TOUGH MATERIAL . . . BUT NOT TOO TOUGH FOR *Watertown*

For years, Watertown has been tackling jobs like this one for R-B-M Division of Essex Wire Corporation, Logansport, Indiana, and coming up with the right answer.

R-B-M needed molded plastic parts for two new devices recently announced — reversing and non-reversing industrial contactors. These contactors are used on hoists, overhead doors, machine tools and other industrial equipment where long dependable service is mandatory.

Melamine was selected for the job — it safely withstood all the elements of tropical warfare in vital aircraft engine parts, and its high arc resistant characteristic makes it ideally suited for electrical insulation.

Melamine, while more difficult to mold and machine than phenolic or cold molded insulation, is preferred as its slightly higher cost is more than offset by its superior insulating quality.

Watertown engineeering developed a method to mold these complex parts with all their slots, holes, recesses, studs, bosses and metal inserts at a reasonable price.

Experience since 1915 with every type of plastic and countless jobs involving compression, transfer or injection molding enable Watertown engineers to tackle just about anything involving plastics. Perhaps you have a problem, too.

THE WATERTOWN MANUFACTURING CO.
600 ECHO LAKE RD., WATERTOWN, CONN.

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

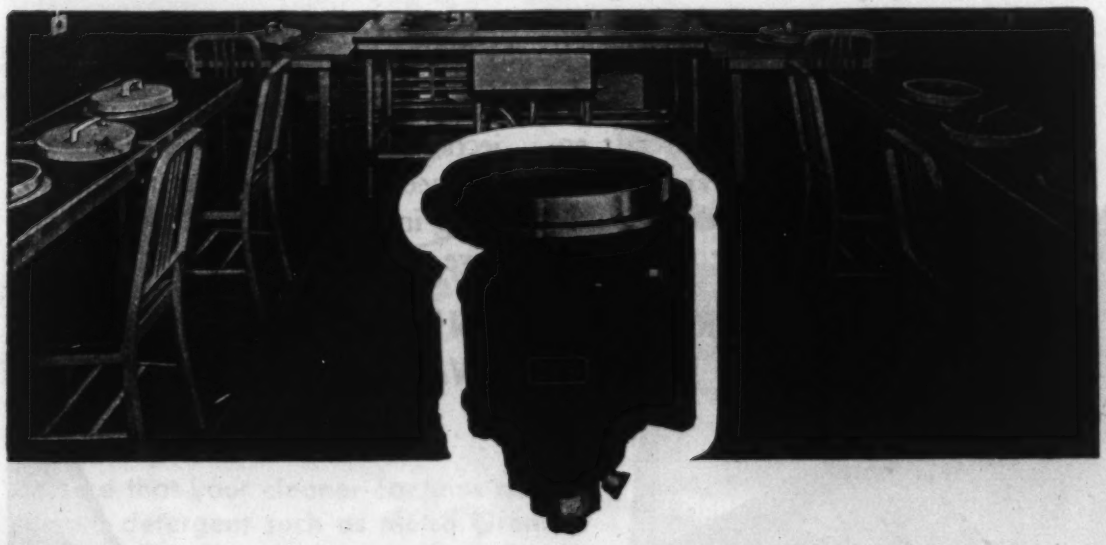
The accepted melting tool in brass rolling mills throughout the world.

* *Upwards of 5 billion pounds annually.*

AJAX ELECTRIC FURNACE CORP.
1108 Frankford Avenue • Philadelphia 25, Pa.

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*



The Cincinnati METALLOGRAPHIC POLISHING MACHINE produces SCRATCH-FREE SPECIMENS EVERY TIME!

Features

- No belts, no friction drive — direct-connected.
- No excessive noise or vibration.
- No splashing of polishing materials.
- Bronze bowl, disk and ring resist corrosion.
- Ball bearing throughout.
- Easy to clean.

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News of...

ENGINEERS COMPANIES SOCIETIES

Engineers

Walter C. Reed, who was among the first to perfect the use of silver solder for brazing, has retired from General Electric Co., Pittsfield, Mass., after 20 years as a development engineer in the laboratories. He has established a consulting engineering office in Dalton, Mass. His outstanding achievements were his development of alloys and fluxes and methods of making joints involving metal parts. He initiated the application of induction heating and resistance heating for silver brazing and soft soldering of joints on an automatic production basis.

William B. Brooks, formerly consulting metallurgist in Pittsburgh, is now research and development engineer with the Dow Chemical Co. at Freeport, Texas, where he will continue his specialization in the fabrication, materials engineering and corrosion of process equipment.

Dr. *William Marsh Baldwin, Jr.,* an associate of Chase Brass & Copper Co., Cleveland, for some years, has been made research professor of metallurgy at Case Institute of Technology, Cleveland. He was graduated from Rensselaer Polytechnic Institute in 1936 as a chemical engineer.

Dr. *G. C. Kuczynski,* a specialist in the electron theory of metals at the metallurgical research laboratories, Sylvania Electric Products, Inc., will deliver a series of lectures on the physics of metals at the National University, Bogota, Colombia. He taught mathematical physics and chemistry at the University of Cracow from 1936 to 1939, later doing spectrographic and similar types of metallurgical analysis. He has studied corrosion of magnesium alloys, and in 1946 received the Baldwin-Southwark fellowship award for fundamental work on strain gage wires.

Joseph Chini has been made superintendent of the Foundry Div., Sperry Gyroscope Co., after studying metal processes at the Velberter Hochschule in Germany. Mr. Chini came to the United States and has specialized in foundry techniques for 31 years. Prior to joining Sperry as general foreman in 1943, he was superintendent of the Howard foundry in Chicago.

Waldemar Naujoks has joined Girard Associates, forge and press engineers with main offices in Chambersburg, Pa., where he will specialize in forge shop problems and sales. He was for many years chief engineer, Steel Improvement & Forge Co.,

Announcing the

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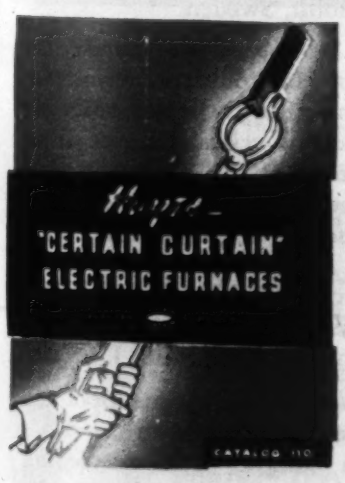
A completely separate building, equipped and staffed to establish the most effective furnace atmospheres and heat treating procedures for each customer's individual requirements.



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CATALOG 110

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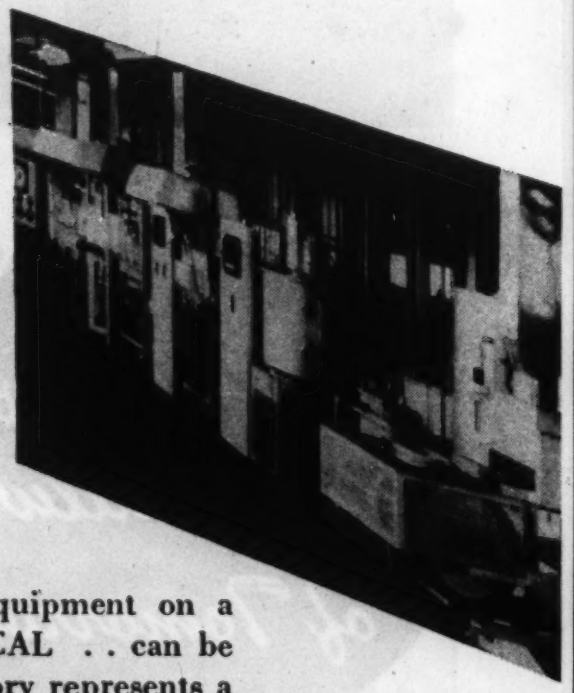

Here your samples are heat treated in production equipment on a production basis. The results established are PRACTICAL . . can be duplicated in your own plant. The new Hayes Laboratory represents a great forward step toward more effective heat treating practice — a step such as you would expect from makers of the world's leading controlled-atmosphere furnaces.

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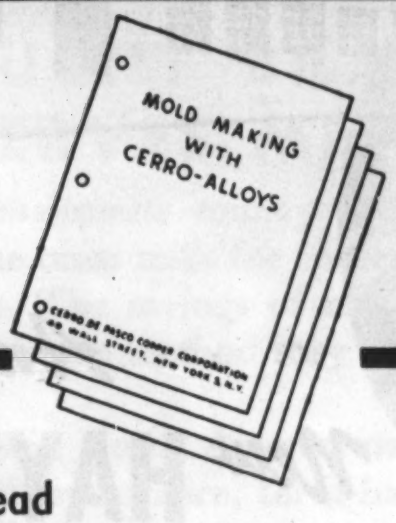

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News of...

ENGINEERS COMPANIES SOCIETIES

Cleveland, and more recently manager, Forged Valve Div., Ohio Injector Corp., Wadsworth, Ohio. He has written several books and articles on forging practice.

L. S. Cope has been made head of research and product engineering at Oliver Iron & Steel Corp., Pittsburgh, where he will technically direct die and tool engineering, metallurgical and special mechanical engineering and product development. He was formerly general manager in charge of production with Oliver.

W. M. Ball, Jr. has become metallurgist and foundry consultant with R. Lavin & Sons, Inc., Chicago 23, having for the past 27 years been superintendent of the foundry of Magnus Brass Div., National Lead Co., at Cincinnati. He has been prominent in work with technical societies, and is recognized as a stimulating and well versed speaker on nonferrous foundry practice. Earlier positions were with Westinghouse and Morgan Engineering Co.

Dr. *Robert F. Mehl,* director, Metals Research Laboratory, Carnegie Institute of Technology, has been named chairman, committee on ship steel, National Research Council, which will determine the metallurgical causes of brittle fracture in ship steel during War II. Dr. Mehl has also been appointed to the advisory committee to the Secretary of Commerce on the National Bureau of Standards. He has recently returned from Europe, where he delivered the Hatfield Memorial lecture at London and addressed the Swedish Metallographers' Society and the Royal Institute of Technology in Stockholm, Sweden.

Dr. *Morris Steinberg* has joined the laboratory staff of Horizons, Inc., Princeton, N. J., in the metallurgy department. He received a master of science degree from Massachusetts Institute of Technology in June, 1946, and a doctorate there two years later. He served in the ordnance department of the Air Forces during the war. He is a member of several technical societies and has authored articles on powder metallurgy, usually collaborating with J. Wulff.

George C. Gibbons has been appointed resident manager of the Norton Co.'s bauxite plant in Bauxite, Ark., succeeding *C. Lawton Rucker,* who retired after 32 years with the Norton Co.

Herbert Pancake, manager, Mine Car Div., American Car & Foundry Co., is now also serving as manager of the Special Products Div., which has taken over the Weldments Div.

Myron S. Curtis has become director of engineering, Warner & Swasey Co., succeeding *William J. Burger,* who retired June 30. He has been helping in the development of new products, such as the Warner & Swasey Sulzer weaving machine. He is a graduate mechanical engineer, and

DPi

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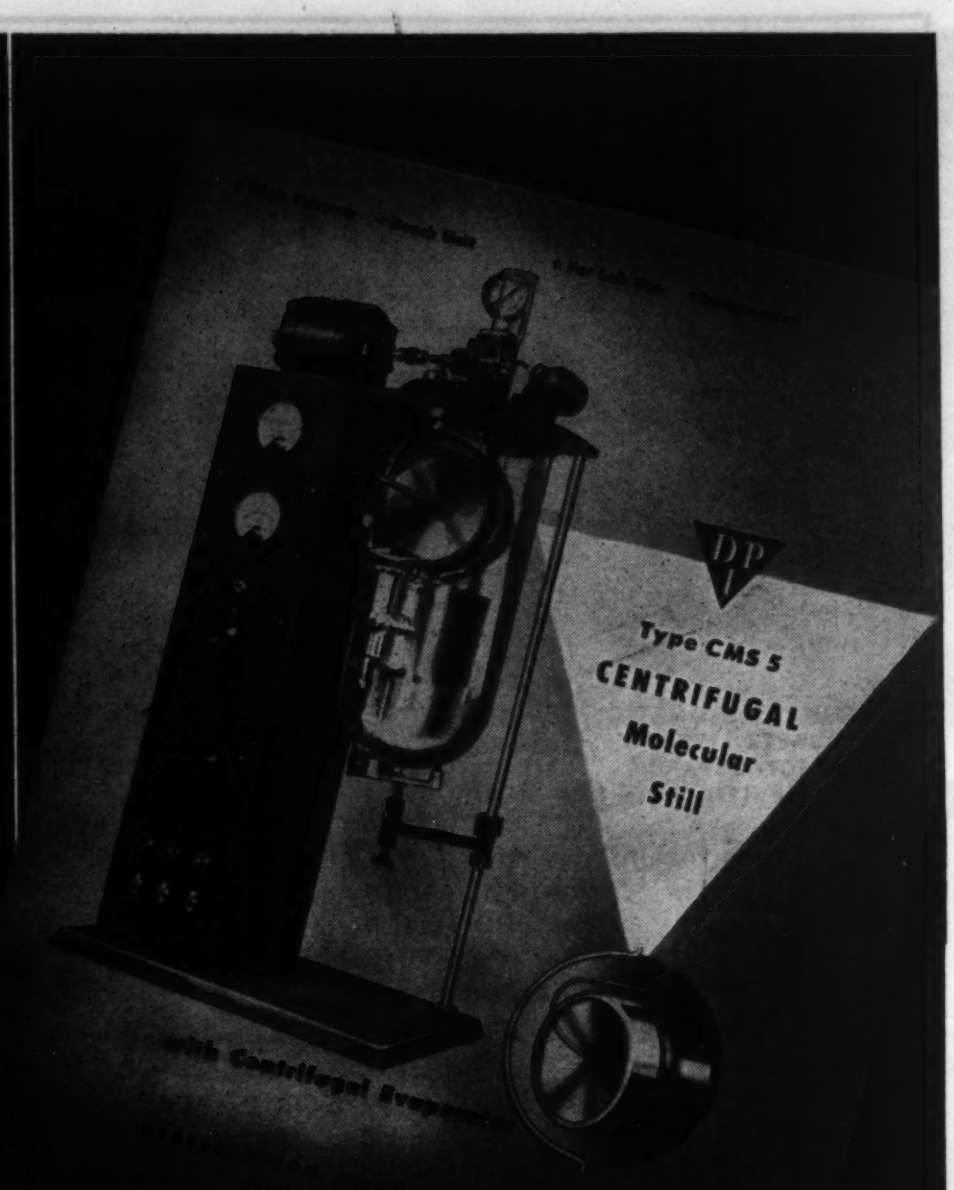

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RESEARCH men in universities and in all industries who work with natural and synthetic substances will welcome this new tool—the CMS 5.

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. . . which gives full description of this complete, compact (3 sq. ft. by 32″ high) unit, and shows how this still can be a useful addition to your present laboratory facilities.

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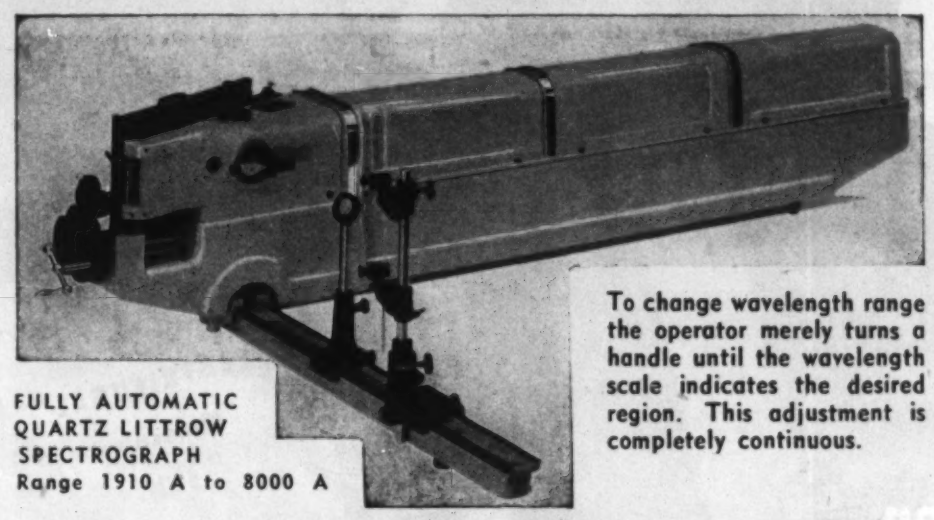

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precision casting sales and engineering

News of...

ENGINEERS COMPANIES SOCIETIES

spent 25 years with Potter & Johnston Machine Co., Pawtucket, R. I.

Dr. *Truman P. Kohman* and Dr. *Robert G. Parr,* both nuclear scientists of Washington, D. C., have joined the Department of Chemistry of Carnegie Institute of Technology, the former teaching nuclear chemistry and the latter, theoretical chemistry. Dr. Kohman was a group leader for the Manhattan project at the University of Chicago, and was chemist at the Hanford, Wash., atomic center. Dr. Parr is an expert on molecular structures and high temperature thermo-dynamics, during the war studying explosives and propellant burning.

Walter George Wheeler has been made chief engineer, Hufford Machine Works, Inc., Redondo Beach, Calif., maker of hydraulic stretch forming machines, hydraulic presses and special hydraulic equipment.

Robert L. Stubbs, expert on Cecostamping and sheet metal fabrication, has been retained by Chambersburg Engineering Co., Chambersburg, Pa., originator of the Cecostamp, as consultant. He operated the first Cecostamp delivered to Consolidated Aircraft in San Diego in 1937 and set up 30 machines for Bell Aircraft. In 1944 he did similar work with ACF-Brill Motors, Philadelphia, engaged in producing bus bodies.

A. C. Monteith has been elected vice president in charge of engineering and research, Westinghouse Electric Corp. He has authored numerous papers and articles, and is a winner of the company's Order of Merit, highest award given by Westinghouse.

Companies

SKF Industries, Inc., has adopted as part of the curriculum of the management training course transcriptions from an hour-long radio broadcast, "Communism—U. S. Brand." The recordings are being included in the courses for foremen and supervisory personnel. Officials describe the dramatization as an "excellent example of a sound educational approach to a subject that should be thoroughly understood by everyone." It will be part of the program on economics and good government.

Two more companies have entered or expanded the field of manufacture of metal powder or powdered metal products. The *International Powder Metallurgy Co.* was recently organized at Ridgway, Pa., for manufacture of products, with M. T. Victor elected president. The *Superior Metal Powders Corp.,* Toledo, Ohio, has entered the manufacture of copper powder for use in powder metallurgy, paint and chemical in-

This typical G-E "Packaged Process" includes two roller-hearth electric furnaces, protective atmosphere producers, control equipment, and conveyor system—for annealing malleable iron castings.

Wrap up your heating process in a *G-E "Package"

Here's the complete, economical answer to industrial heating problems—General Electric "Packaged" Heating Processes. Designed to do the *entire* job, a G-E "Packaged Process" provides you with a single source of supply for all of the following:

EQUIPMENT—A G-E "Packaged Process" combines one or more furnace units from the outstanding G-E electric furnace line—roller-hearth, mesh-belt, elevator, pit, car-bottom, etc.—with appropriate G-E protective atmosphere producers, automatic controls, conveyers, and handling equipment. This "process packaging" of G-E equipment assures maximum performance through proper coordination of every component . . . eliminates "misfits" . . . saves you time and expense.

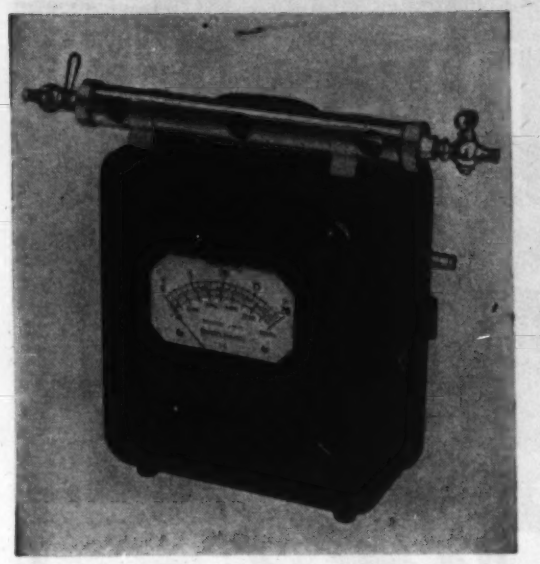
ENGINEERING—Your process becomes the "focal point" for applying all of General Electric's 40 years' experience in designing, manufacturing, and applying industrial heating equipment. Expert G-E engineers advise and plan right with you from start to finish.

FIELD SERVICE—G.E.'s nationwide field service stands ready to supervise your installation, help solve operating problems, and to perform emergency repairs at any time.

Contact the heating specialist in your nearest G-E office for additional information on G-E "Packaged" Heating Processes (or for information on electronic heaters and small heating devices); or, write *Dept. 675-177, Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

Check CO_2 Efficiently!



Engelhard portable CO_2 Gas Analyser permits quick determination of heat treating furnace conditions efficiently, without taking samples of combustion gases back to the laboratory. This means that furnace atmosphere conditions are known instantly and any necessary furnace adjustments can be made on the job with visual measurement on a direct reading meter.

This FLUALYZER, as we like to call it, is an instrument incorporating sensitivity, ruggedness and complete portability. The ENGELHARD thermal conductivity method of gas analysis assures highest accuracy. To complete the setup, temperature readings of flue gases can also be taken with the same instrument, if you desire.

Write for prices and Bulletin 700

CHARLES ENGELHARD, INCORPORATED

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- ROK-LOK—new sensitive material clamp increases accuracy
- DOUBLE-EDGED FORMING BLADE allows close reverse bends
- NEW PRECISION STOPS accurately control angularity of bends

This versatile metal forming machine was developed for use in model shops, experimental laboratories and production departments where it often replaces dies for all types of precision forming operations. Di-Acro Brakes will form a great variety of materials including bronze, stainless steel, aluminum and bi-metals.

WRITE FOR CATALOG. New edition of 40-page Di-Acro Catalog contains detailed information on all Di-Acro Brakes, Shears, and Benders and illustrates how these precision machines can be used individually or cooperatively for "DIE-LESS DUPLICATING".

◀ DI-ACRO is Pronounced "Die-Ack-Ro"

DI-ACRO PRECISION MACHINES DIE-LESS DUPLICATING

O'NEIL-IRWIN MFG. CO.

382 8TH AVE., LAKE CITY, MINNESOTA

News of...

ENGINEERS COMPANIES SOCIETIES

dustries. The company has already been making iron powder.

F. W. Berk & Co., Inc., 420 Lexington Ave., New York 17, long time producer of mercury and mercurials, has entered the zirconium field as a basic integrated producer of zirconium products. Using raw materials from Australia, the company is producing zirconium salts at its plant at Wood Ridge, N. J. It plans to have all types of zirconium products for the chemical, ceramic and metallurgical industries.

The *Carnegie-Illinois Steel Corp.* and *American Bridge Co.* have proposed to Eastern railroads reductions in freight rates by 40% on iron and steel articles moving from Pittsburgh to New York and Detroit. The move is necessary, the petitioners say, because of the new f.o.b. mill pricing system in place of the multiple basing point system. They point out, too, that a reduction will be to the advantage of the railroads because of the growing tendency to use water transportation.

The *Cyril Bath Co.*, Cleveland, machine tool and special machinery maker, has acquired Goodyear patents on roto forming in the United States, Canada and England. The patents on a process used during the war involves stretching metals to their elastic limits and, while under tension, forming upon a rotary moving table. Parts are formed for aircraft, automotive and home appliance industries. The process is known as both contour forming and roto stretching. Certain economies are claimed in processing aluminum, stainless steel, magnesium, bronze and other high cost alloys.

The *Kennecott Copper Corp.* and *New Jersey Zinc Co.* plan to spend $25,000,000 in the development of a titanium ore deposit in Quebec. The product will be used in paint, and titanium-bearing pig iron will also be produced. The sponsors claim this is the largest known deposit of titanium in the world.

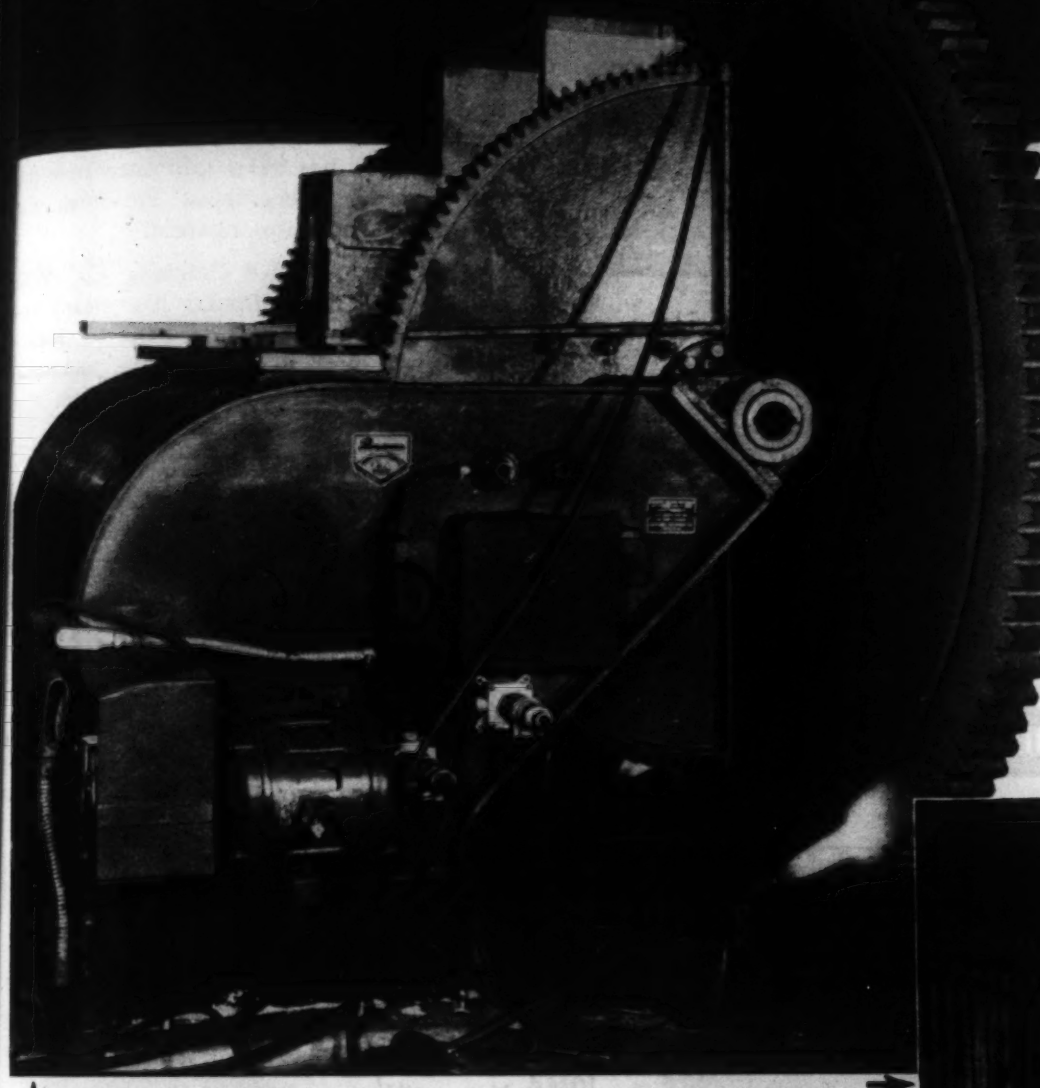
The *Harvard Foundry Co.*, Chicago 39, has purchased the magnesium foundry at Belmont, Calif., formerly owned by Dalmo-Victor, San Francisco. Here was manufactured large tonnages of magnesium incendiary bombs during the war, as well as a wide range of magnesium aircraft castings. Harvard now owns six foundries, including those in Chicago and Los Angeles.

The *Scovill Mfg. Co.*, Waterbury, Conn., expects to have completed by year end a new building to house one of the fastest and most efficient nonferrous mills in the country for cold rolling copper-base alloys in sheet and strip form. A single annealing furnace can handle 33,000 lb. of brass per hr., the owners claiming highest capacity in the nonferrous industry.

The *Tinius Olsen Testing Machine Co.* is now located in new modern offices and

These pictures SHOW you...

This bulletin TELLS you...



Ransome 12 Ton Welding Positioner at Marion Power Shovel Co., Marion, O. Gear being welded and preheated at same time.

Ransome 2500 lb. Welding Positioner being used with automatic welding head at Wooldridge Mfg. Co., Sunnyvale, California.

how Ransome "DOWNHAND" welding positioning

- ups production 50%
- cuts work in half
- gives better, neater welds
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- makes work safer

RANSOME POSITIONERS . . . constant or variable speed rotation through full 360° in either direction . . . wide welding speed range . . . 135° tilting hand or motorized as required . . . permits Downhand welding at any angle . . . capacities 100 lb. to 40,000 lb.

RANSOME TURNING ROLLS . . . standard capacities 4½ to 45 tons, stationary or self-propelled, also larger sizes available.

Ransome — 50% PRODUCTION UP — LABOR COSTS DOWN — WELDING POSITIONERS

INDUSTRIAL DIVISION
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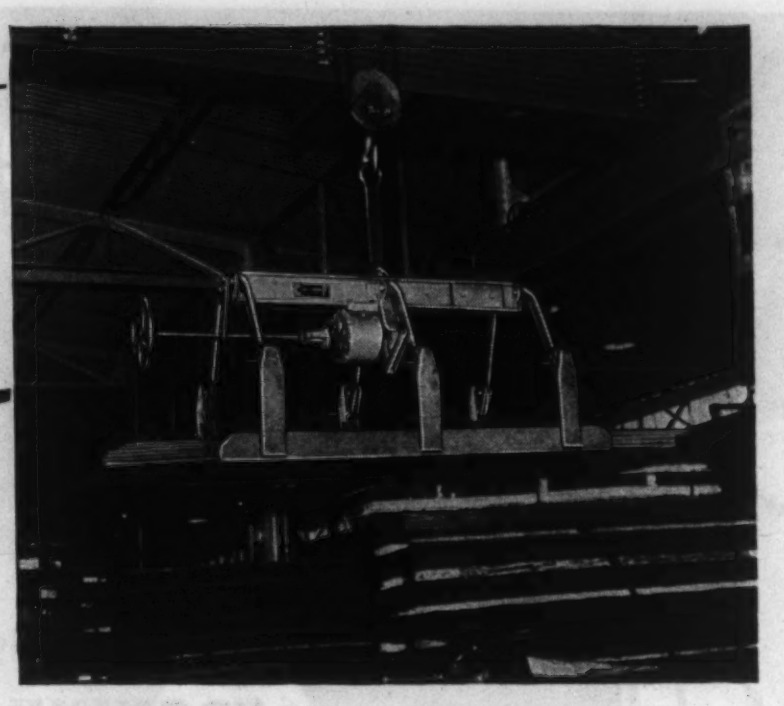
Save SHEETS



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Handle loose or bundled sheets with one of these C-F Lifters and you save TIME and SHEETS, because C-F Lifters under one man end control can handle more sheets per load safer, faster and more economically. Tong action grips loads tightly, yet design features like wide bearing surfaces give full protection to stock edges. End control of C-F Lifters permits closer stocking of piles—resulting in more efficient use of storage facilities.

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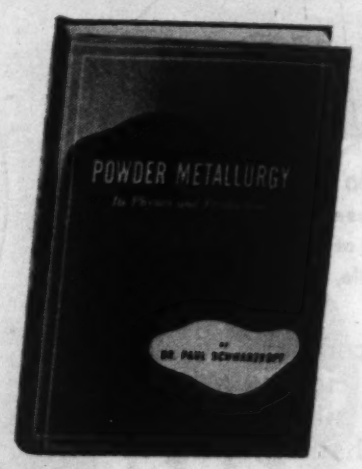
HANDLE SHEETS with C-F LIFTERS

WHAT CAN POWDER METALLURGY DO FOR YOU?

This book tells you, in complete detail, the production methods, characteristics, and uses of products that may be of great advantage to you.



POWDER METALLURGY

- is written by *Dr. Paul Schwarzkopf, President of the American Electro Metal Corp.*, and his associates. Dr. Schwarzkopf has spent 30 years in the highly successful development of powder metallurgy and holds hundreds of the basic patents. In this book he gives much production information usually unobtainable on a developing technology.
- fully explains the production, characteristics and uses of dense materials, porous products, refractory metals, hard metals, electric contact materials, magnetic materials, and friction parts. It includes the underlying theory as well as practical techniques.
- covers the latest postwar developments, both here and abroad, on both the theoretical and the production aspects of the subject, with highly valuable material on high-strength, heat-resistant materials of special importance in many current engineering problems.

"The best, most stimulating work on the subject . . . It will not only repay but will demand most careful study. Every metallurgist will want to have and use this book."

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News of...

ENGINEERS
COMPANIES
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plant on Easton Rd., Willow Grove, Pa., containing over 100,000 sq. ft. of floor area.

The *Allmon Steel Co.* has been organized in the Arrott Bldg., Pittsburgh, to deal in steel for special purposes such as stainless, heat-resisting, clad, tool steel, high-speed steel, forgings, die blocks, etc. The company's name has been fabricated from the two rivers converging at Pittsburgh, the Allegheny and Monongahela.

The *F. J. Stokes Machine Co.*, 5972 Tabor Rd., Philadelphia, has greatly enlarged and improved its shop for manufacture of punches and dies for industrial and pharmaceutical tablet machines, including those for powder metal work.

The *Crane Co.* has made a contribution of $150,000 to the University of Chicago's basic research program to expand our fundamental knowledge of the metallic state, and make possible new and improved metals.

The *General Electric Co.* has hired a record number of over 1400 graduates of 150 colleges and universities this year, or almost 600 more than last year. The company has also granted 46 scholarships and loans totaling $13,150 to employees and their children for undergraduate study in the 1948-49 school year.

The *Cowles Detergent Co.*, Cleveland 3, has changed its name to *Cowles Chemical Co.* because the company has become increasingly diversified.

Bodies for the new *Willys-Overland Motors* "Jeepster," as well as for trucks, are being stamped in the company's own $5,000,000 body stamping shop, with 600 bodies a day turned out on a two-shift basis. Formerly all body stampings were bought from suppliers.

The *Lion Oil Co.*, El Dorado, Ark., is constructing a $250,000 plant for exclusive manufacture of protective coatings.

The *Induction Heating Corp.*, Brooklyn 11, is making available induction and dielectric heating equipment under a rental-purchase plan, which they claim is unique in the heavy equipment field. Their equipment may be rented on a monthly basis with option to buy at any time.

The *Lithgow Corp.*, industrial paints and finishes, has opened a new and modern plant at 42 Belden Ave., Norwalk, Conn.

The *Elmer E. Mills Corp.*, engineers and designers specializing in injection molding and extrusions, have a new plant at 2930 N. Ashland Ave., Chicago 13.

The *Amplex Div., Chrysler Corp.*, Detroit, has completed a major expansion program, with enlarged space and new equipment, largely of very heavy presses to produce bearing and machine parts of larger size than normal.

now all-steel construction!

Lepel

Lepel High-Frequency Heating Units — in 7½, 15 and 30-kw ratings — have been completely redesigned. They are now of all-steel construction—frame, base and panels. Interiors are of the latest fire-resisting materials. Operating controls are arranged for greater convenience. Appearance has been modernized.

AND — all features that have made Lepel units so popular in the high-frequency heating field are retained:

FLEXIBILITY IN WORK — without any auxiliary equipment, a Lepel unit can be used for hardening, annealing, stress relieving, brazing, soldering and melting.

FLEXIBILITY IN OPERATION — A Lepel unit can be used with a large variety of work coils for heating parts of widely different sizes and shapes *without requiring matching transformers and condensers.*

FULL POWER OUTPUT — A Lepel unit delivers its full rated capacity when treating non-ferrous as well as ferrous metals. Power does not drop off, for example, when the metal being heated passes from magnetic to non-magnetic stage or from solid to liquid state.

ECONOMICAL TO OPERATE — A Lepel unit consumes current and water only during the actual heating cycle. It has the lowest water consumption per kilowatt of any high-frequency heating unit — and normal water pressure is adequate. Unity power factor at full-rated output.

If you have any application — on ferrous or non-ferrous materials — which you think might be handled by high-frequency heating, our engineers can run tests, on samples you supply, and report just what can be done. There is no obligation; inquiries are treated with strictest confidence.

A letter to us will bring you, as you prefer, our latest catalog or a call by a representative. Any description of part or process which you can give may enable us to furnish, immediately, specific helpful data.

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MELT

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Philadelphia, Pennsylvania
October 25th-29th inclusive

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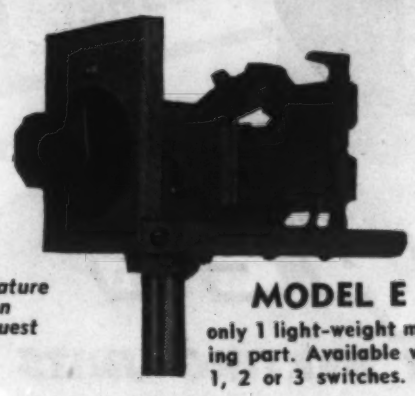
TEMPERATURE LIMIT SWITCHES

USE NO LIQUIDS . . . NO GASES



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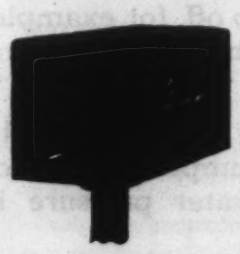
only 1 light-weight moving part. Available with 1, 2 or 3 switches.

As a 3 switch model, Burling Model E is recommended for use (a) where load is divided into 3 parts, (b) where 1 switch is used for controlling, one as a high limit, one as a low limit, (c) to give definite stops or position to a 3 or 4 position diaphragm motor, (d) to give 3 speed control of variable speed motor.

- Accurate, Rugged, Dependable
- Corrosion and heat resisting tube
- Dial Pointer for easy setting
- Locking screw locks temperature setting
- Terminal plate has large screw terminals
- Snap-action Micro-Switch eliminates contact troubles
- Increased Adjustable range to 700-1000°
- Dimensions—7¼" x 2¾" x 3½"

MODEL V-I

For lower temperature range from 0-300°F. Available for minimum of —100° to maximum of 600°F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high.)



MODEL D

Adjustable range 200-500°F. Temperature range 0-1400°F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½ x 2¾ x 2¾".)

Instruments also Built to Specifications

Making Precision Controls for Over 11 Years

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News of...

ENGINEERS COMPANIES SOCIETIES

A new production unit of *Federated Metals Div., American Smelting & Refining Co.*, has gone into operation at the company's expanded Houston, Tex., plant where will be manufactured solders, bearing metals, battery metals, lead ingot, type metals, and special white metal alloys.

In cooperation with the Navy, the *Westinghouse Electric Corp.* at Philadelphia will reactivate and operate the Naval industrial reserve plant at Kansas City, Mo., for production of axial-flow jet aircraft engines on which Westinghouse pioneered.

The *Federal Machine & Welder Co.* has bought the plant of the Warren City Mfg. Co., Warren, Ohio, from the Navy.

Societies

The *Gray Iron Founders' Society* will hold its 20th annual meeting and convention at Haddon Hall, Atlantic City, Oct. 14-15. Among the speeches will be one by William B. Given, president, American Brake Shoe Co., on "Rating Better People in Our Foundries." The Society has published a new free bulletin, "Gray Iron—Its Mechanical and Engineering Characteristics and Details for Designing Cast Components," obtainable at 33 Public Square, Cleveland 13. The Society has arranged for pig iron to be shipped to 200 New England foundries from the Buffalo plant of the Colorado Fuel & Iron Co. to make up the deficit because of the sudden breakdown of the furnace of the Mystic Iron Works at Everett, Mass.

At the *International Powder Metallurgy Conference* at Graz, Austria, in July the honorary degree of "Doctor of Technical Sciences" was conferred by the Technische Hochschule of Graz on the following: Dr. W. D. Jones, London; Dr. Paul Schwarzkopf, Yonkers, N. Y.; Prof. J. A. Hedvall, Goeteborg, Sweden; Prof. A. F. Joffe, Moscow; and Prof. L. Neel, Grenoble, France.

The *American Standards Assn.* became the *American Standards Assn., Inc.* Aug. 2 under the laws of the State of New York. It was organized in 1918 as the American Engineering Standards Committee, representing five technical societies. In 1928 an entire reorganization took place, then becoming American Standards Assn. Bills seeking Federal incorporation are now before Congress. The Association now performs standardization in mechanical, electrical, building, photographic, mining, safety and consumer goods fields as well as in more general fields.

The *Engineering Foundation* has created a council to study and research in reinforced

COMMON SENSE in the shop would seem to call for careful cutting fluid application, because oil that improves one operation may not be right for something different. *There just isn't any "one shot" cutting fluid that can do a large percentage of all jobs!* Consider all the variables—the wide variety of speeds, feeds, materials, tolerance and finish requirements encountered in machining operations in one shop. Those are the considerations that make it economical in the long run to be sure the cutting fluid you use is scientifically correct. "On-the-job" tests help you determine what cutting oil qualities are needed, and may even result in a decrease in the number of oils now used. It is plain common sense to call in cutting oil experts . . . people with a sound background of practical experience who can be relied upon to recommend the right cutting fluid for the job.

—Chip

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water mixed cutting compound

Solvol is more than just a high grade, emulsifiable cutting fluid. It is a unique super soluble product with the extra metal cutting qualities that will solve some of your machinery problems and help eliminate production headaches. Ask for literature.

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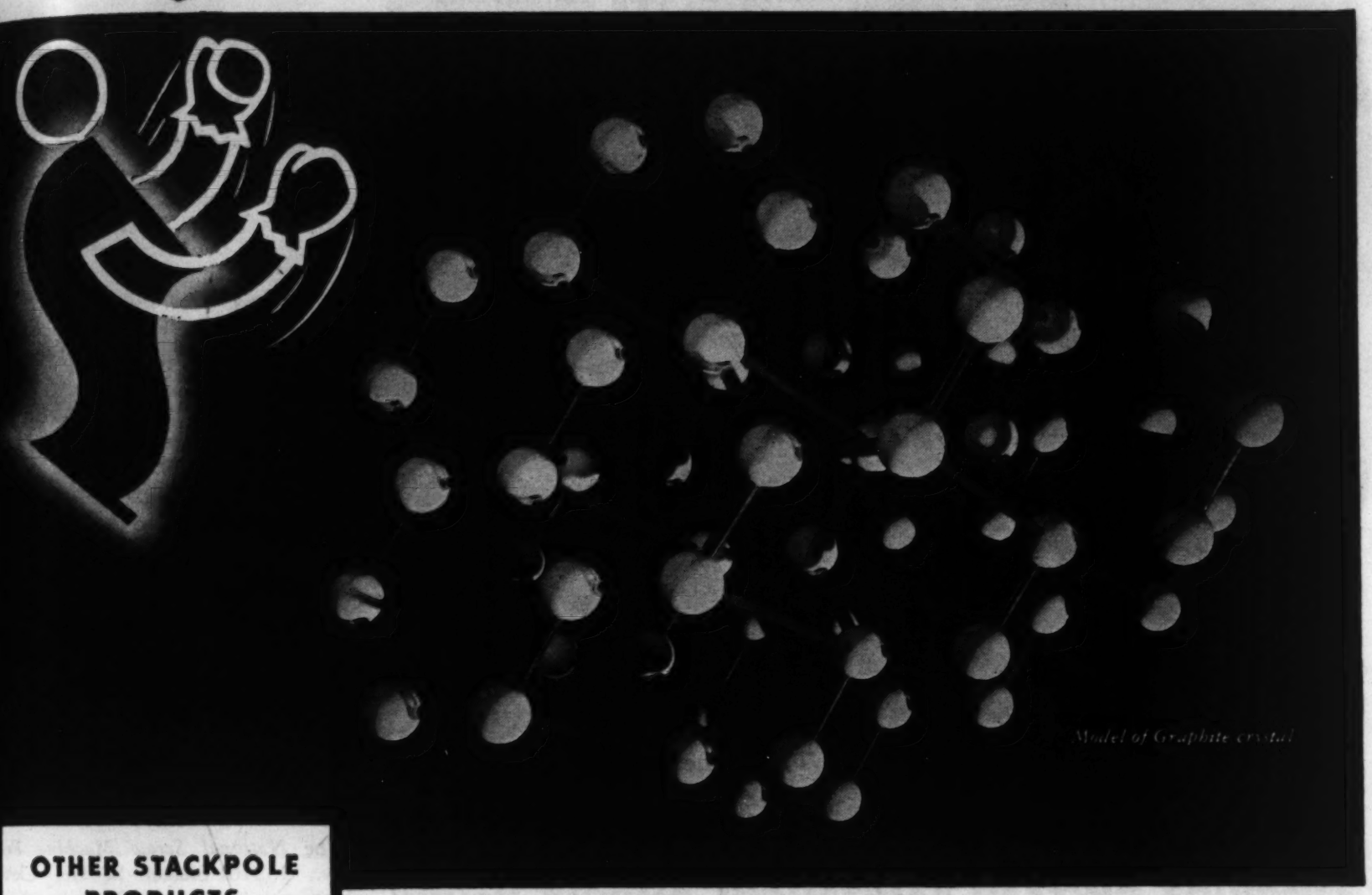

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Stackpole Carbon and Graphite components handle all of these assignments —and many more. Chemically, electrically, and mechanically, Carbon and Graphite offer far flung engineering advantages—and, for almost a quarter of a century, Stackpole design and production service has paced the trend in progress along many important lines.

WRITE FOR THIS BIG CARBON GRAPHITE BOOK!

In addition to a wealth of informative data, the new Stackpole Carbon-Graphite Specialties Catalog #40 describes hundreds of items regularly produced. More particularly, it contains interesting evidence of the ability of Carbon and Graphite to solve a broad range of design, engineering and production problems—and of Stackpole's facilities for producing what is needed.

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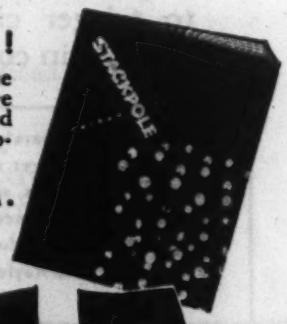

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This panel view shows how easily determination is indicated for constituents in a typical steel analysis.

Production control analysis, for the desired constituents, is obtained within 40 seconds after the operator has pushed the button that initiates the automatic analyzing cycle. The analysis requires no photographic darkroom, no specialized operating techniques, and no reading of graphs.

Precision of analytical determinations is equal or superior to that of present photographic means using conventional spectrographs.

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Other special apparatus produced by Baird Associates, Inc. over the past decade include spectrographs, spectrographic power sources, density balances, infra-red spectrophotometers, microphotometers, infra-red gas analyzers, and Rayleigh interferometers.

Baird Associates-Dow Direct-Reading Spectrometer offers the advantages of faster control analyses and restoration of skilled laboratory staffs to other functions. For detailed information, request Bulletin 26.

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News of...
ENGINEERS COMPANIES SOCIETIES

concrete and to interpret the results in the form of a code for the design of concrete structures. It is anticipated that such a code may permit use of reinforced concrete in longer spans. In the past, concrete and steel have been combined and the design was based on the incorrect assumption that the strain in the concrete is, as in steel, proportional to the stress. But with concrete, states Dr. A. B. Kinzel, chairman of the Foundation's board, the engineer is dealing with a material in which deformation is not proportional to the stress.

A tentative program for a *National Conference on Industrial Hydraulics* at the Hotel Sheraton, Chicago, Oct. 20, has been announced by S. F. Musselman, assistant chairman, applied mechanics research, Armour Research Foundation, Technology Center, Chicago 16. Along with the program is a brief prospectus of each technical paper.

The *American Society of Body Engineers* will hold its annual convention at the Rackham Memorial Bldg., Detroit, Nov. 3-5. Technical sessions include styling, production engineering, small cars, busses and coaches, commercial bodies, body fabrication, stress analysis and testing and passenger car body engineering.

The *National Screw Machine Products Assn.*, 13210 Shaker Square, Cleveland, which sponsors two $1500 national scholarship awards, covering a 3-year course at the Rochester Institute of Technology, have announced the first successful candidates. They are Bruce Watkins, Osceola, Ind., and John M. Carney, Elyria, Ohio. Both are 18 and were graduated from high school in 1948. Scholarships are dedicated to: Aiding development of new techniques and improving standard methods of screw machining; helping provide better-informed technical supervision for the future benefit of the screw machine products industry; help solve the many problems that confront the industry every day.

The *National Electronics Conference* will be held at the Edgewater Beach Hotel, Chicago, Nov. 4-6. The technical program will deal with new materials, sound measurement and recording, servo-mechanisms, communications, electronic instrumentation, new tube developments, microwaves, computors, industrial applications, television, management of research, electronic circuits, magnetic amplifiers and antennas. Conference details may be obtained from Dr. R. R. Buss, secretary, Electrical Engineering Dept., Northwestern University, Evanston, Ill.

The *Society for Applied Spectroscopy* is holding a series of technical meetings the first Tuesday of each month, starting Oct. 5 and extending into February, in the Socony Vacuum Training Center, 63 Park Row, New York, starting at 8 p.m. The

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Drop in at the Lindberg Booth (#344) during the metal show (Oct. 25-29 Philadelphia). Lindberg engineers will be glad to discuss your heating problems. If you have nothing in mind at the moment, drop in anyway. You'll see . . .

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When you're buying a BIG furnace, is it more economical to have it constructed entirely in your own plant, or is it better to have it factory-built and shipped to your plant in freight-car-size sections?

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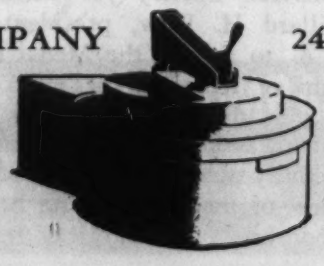

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News of...

ENGINEERS
COMPANIES
SOCIETIES

chairman of the society is Dr. E. K. Jaycox, Bell Telephone Laboratories, Murray Hill, N. J.

Philip D. Reed, chairman of the Board, *General Electric Co.*, has been made chairman of the research and policy committee of the Committee for Economic Development.

The *Society of the Plastics Industry* invited the British Plastics Federation to send a delegation to the National Plastics Exposition at Grand Central Palace, New York, by sending its president, George H. Clark, personally to England to extend the invitation.

Dr. Mario G. Salvadori, assistant professor, civil engineering, Columbia University, represented the *American Society of Civil Engineers* and Columbia University at the seventh International Congress for Applied Mechanics at London in early September.

The graduate division, New York University College of Engineering, has inaugurated a new course, "Effect of Temperature on Materials of Construction." It will present the principles that govern the behavior of metals and nonmetals subjected to certain temperature ranges and to study the techniques used in their engineering use. Included in the studies will be metallurgy of molybdenum, tungsten and powder metallurgy.

The *Purdue University Metals Casting Conference* at Lafayette, Ind. Nov. 4 and 5 will feature separate technical sessions for ferrous and nonferrous groups. The principal speaker for the ferrous group will be R. G. McElwee, manager, iron foundry, Vanadium Corp. of America, while for the nonferrous group, Hiram Brown, chief metallurgist, Solar Aircraft Co., Des Moines, Iowa. Among subjects are: quality control, foundry mechanization, foundry personnel problems, and what the purchaser expects from the foundry.

Dedication of a memorial room to the late Dr. Albert Sauveur, pioneer in the science of metals, took place in the national offices of the *American Society for Metals*, Cleveland, Aug. 19. The room, 40 by 15 ft., has been completely redecorated and equipped with built-in, glass-enclosed cases for displaying the many records and honors belonging to Dr. Sauveur, who has been called the "dean of American metallurgists."

The *American Society for Metals* has chosen Willard H. Dow, president, Dow Chemical Co., to receive the Medal for the Advancement of Research for 1948. Requisites are that the candidate shall be an executive of an industrial organization, the principal activity of which is the production or fabrication of metals and who has consistently sponsored metallurgical research.

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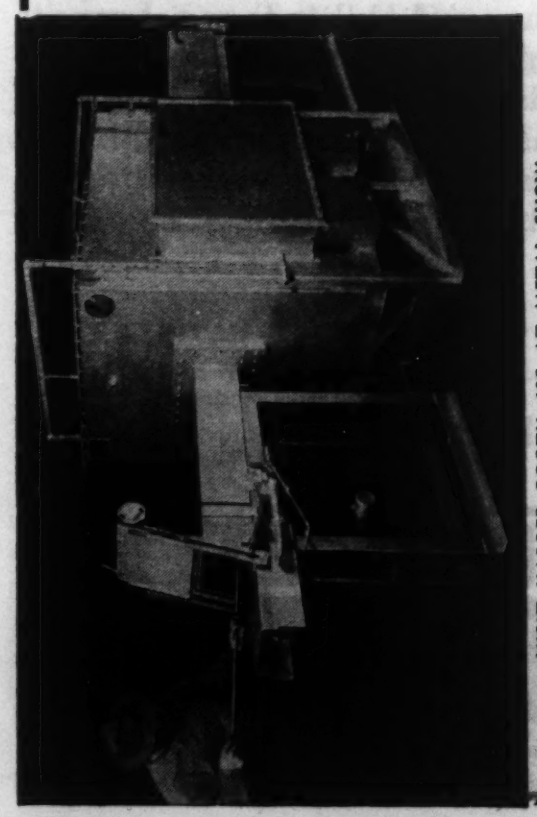

VISIT HARPER BOOTH 605 AT METAL SHOW

Meetings and Expositions

MAGNESIUM ASSOCIATION, mid-year meeting. Skytop, Pa., Oct. 13-14, 1948.

AMERICAN SOCIETY OF CIVIL ENGINEERS, fall meeting. Boston, Mass. Oct. 13-15, 1948.

PORCELAIN ENAMEL INSTITUTE, annual forum. Urbana, Ill. Oct. 13-15, 1948.

ELECTROCHEMICAL SOCIETY, fall meeting. New York, N. Y. Oct. 13-16, 1948.

FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION, annual meeting. White Sulphur Springs, W. Va. Oct. 14-15, 1948.

GRAY IRON FOUNDERS SOCIETY, annual meeting. Atlantic City, N. J. Oct. 14-15, 1948.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Midwest general meeting. Milwaukee, Wis. Oct. 18-22, 1948.

AMERICAN WELDING SOCIETY, annual meeting. Philadelphia, Pa. Oct. 18-22, 1948.

WIRE ASSOCIATION, annual meeting. Pittsburgh, Pa. Oct. 18-22, 1948.

NON-FERROUS FOUNDERS' SOCIETY, annual meeting. Philadelphia, Pa. Oct. 22, 1948.

METAL TREATING INSTITUTE, annual meeting. Philadelphia, Pa. Oct. 22-25, 1948.

AMERICAN WELDING SOCIETY, annual meeting. Philadelphia, Pa. Oct. 24-30, 1948.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Institute of Metals Div. fall meeting. Philadelphia, Pa. Oct. 25-27, 1948.

AMERICAN SOCIETY FOR METALS, annual meeting. Philadelphia, Pa. Oct. 25-29, 1948.

NATIONAL METAL CONGRESS AND EXPOSITION. Philadelphia, Pa. Oct. 25-29, 1948.

NATIONAL BUSINESS SHOW. New York, N. Y. Oct. 25-30, 1948.

SOCIETY FOR NON-DESTRUCTIVE TESTING, annual meeting. Philadelphia, Pa. Oct. 27-28, 1948.

PORCELAIN ENAMEL INSTITUTE, annual meeting. Chicago, Ill. Oct. 28-29, 1948.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Coal Div., and AMERICAN SOCIETY OF MECHANICAL ENGINEERS, Fuels Div. meeting. White Sulphur Springs, W. Va. Nov. 3-4, 1948.

AMERICAN SOCIETY OF BODY ENGINEERS, annual convention. Detroit, Mich. Nov. 3-5, 1948.

METALS CASTING CONFERENCE, West Lafayette, Ind. Nov. 4-5, 1948.

SOCIETY OF AUTOMOTIVE ENGINEERS, fuels and lubricants meeting. Mayo, Tulsa, Okla. Nov. 4-5, 1948.

NATIONAL ELECTRONICS CONFERENCE, annual forum. Chicago, Ill. Nov. 4-6, 1948.

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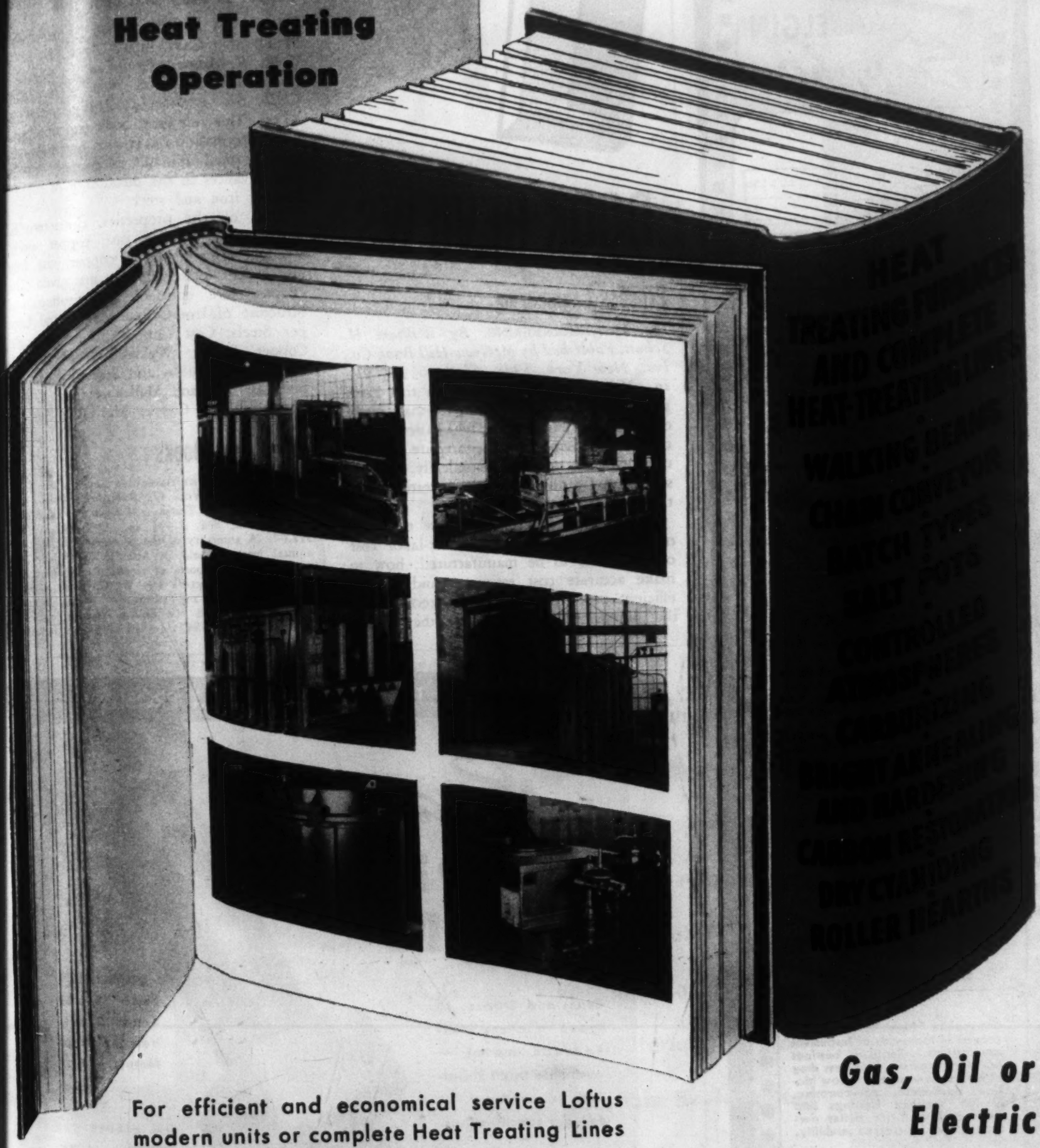

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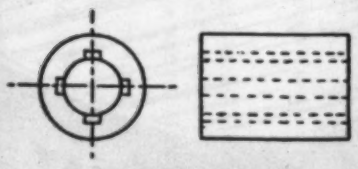

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Sapphire bearings operate longer, more accurately, and often with less friction than so-called "antifriction" types. Recommended for those tough applications of higher speeds and poor lubricating conditions. Sizes of Sapphire inserted bearings from .250 to 1.500 I.D., length to suit. Smaller sleeve bearings from .003 to .500 of solid Sapphire.

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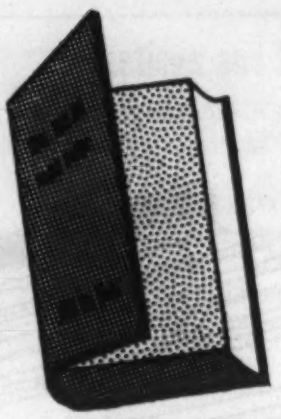

BOOK REVIEWS

Process Engineering

PROCESS ENGINEERING. *By William H. Schutt. Published by McGraw-Hill Book Co., Inc., New York, 1948. Cloth, 6¼ x 9¼ in., 309 pages. Price $4.00.* In this book process engineering refers to that phase of industrial engineering which determines the means, methods, and procedure of manufacturing an article economically. Emphasis is heavily on machining operations and their cost-estimating.

Information is given on how to determine the selling price or direct-labor cost of an article to be manufactured; how to make accurate cost estimates and set up efficient production methods directly from the blueprint; how to select the proper material for economical production; and how to estimate the size of blanks for forming various products.

Copper in Steel and Cast Iron

COPPER AS AN ALLOYING ELEMENT IN STEEL AND CAST IRON. *By C. H. Lorig & R. R. Adams. Published by McGraw-Hill Book Co., Inc., New York, 1948. Cloth, 6¼ x 9¼ in., 213 pages. Price $3.00.* This reference book contains pertinent information on ferrous materials containing small amounts of copper, and recent advances in the metallurgy of copper-bearing iron and steel.

Data on the properties, characteristics, and applications of cast copper steels, wrought copper steels, copper cast iron and copper malleable iron are given. The chapters are entitled: Constitution and Structure of Iron-Copper Alloys and Copper Steels; Cast Copper Steels; Wrought Copper Steels; Weldability of Copper Steels; Constitution and Structure of Copper Cast Iron and Malleable Iron; Copper Cast Iron; and Copper Malleable Iron.

Other New Books

PROCEEDINGS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS. VOL. 47. *Published by the American Society for Testing Materials, Philadelphia, 1948. Cloth, 6¼ x 9¼ in., 1197 pages. Price $12.00.* A summary of the proceedings of the 50th annual meeting, held in Atlantic City, June 16th to 20th, 1947, reports of technical committees, the Edgar Marburg lecture (by W. C. Voss), over 40 technical papers, and summaries of six symposia (including that at the Spring Meeting in Philadelphia, Feb. 25, 1947) are contained in this volume.

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